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John H. Kudukey

University of Massachusetts Amherst

AN EVALUATION OF UPDATE: A STUDY OF THE EFFECT OF PARTICIPATION IN A TEACHER ENHANCEMENT PROGRAM ON SECONDARY PHYSICS INSTRUCTION

A Dissertation Presented

by

JOHN H. KUDUKEY

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Approved as to style and content by:

Klaus Schultz

Klaus Schultz, Chair

John Clement

John Clement, Member

R D Konicek

Richard D. Konicek, Member

John Carey

Bailey W. Jackson, Dean
School of Education

DEDICATION

I dedicate this dissertation to my mother, Jessie Kudukey, and to the memory of my father, Henry Kudukey.

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It is with great appreciation I wish to acknowledge the members of my dissertation committee.

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ABSTRACT

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JOHN H. KUDUKEY

MAY 1997

B.A., UNIVERSITY OF MASSACHUSETTS AMHERST

M.Ed., AMERICAN INTERNATIONAL COLLEGE

Ed.D., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Klaus Schultz

Secondary physics education in the United States has been shown to be sub-standard, and not even offered in many high schools. National assessment results have suggested that changes in secondary physics education are greatly needed and are slow in coming. One attempt to enhance physics instruction is the UPDATE program. UPDATE is a physics teacher enhancement program offered by the University of Massachusetts. The program is primarily designed to enhance physics teacher knowledge in topical and important areas of contemporary physics that are not always well represented in secondary classrooms.

This study assesses the impact of participation in the UPDATE program on the high school physics instruction of the 1995-96 program participants. Focus group interviews, individual interviews, and a questionnaire are methods used to collect data. This document includes transcriptions from both focus group and individual interviews, as well as quantitative results from a questionnaire. Commonalities are drawn from the three sources of data to illustrate the impact of the UPDATE program on participants' high school physics instruction. Aspects of the program which have contributed to enhancement of instruction are also identified and recommendations are made for subsequent teacher enhancement programs. The findings generally indicate that participants became more confident, enthusiastic, gained more physics knowledge, and changed their teaching practices to include more UPDATE related topics. In addition, laboratory experiences as well as laboratory equipment offered to participants during the program contributed significantly to their perceived instructional enhancement.

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CHAPTER 1

INTRODUCTION

Over the past decade there has been an immense resurgence of interest in secondary science education in the United States. Many political and corporate leaders are concerned with the preparedness of secondary school students to contribute to and eventually assume leadership in the 21st century. Their concerns are echoed in the media, as on any given day one can read about the crisis in science education in the United States. The concerns have also found their way to political campaigns as some politicians have made science education a popular issue, such as former President Bush who stated during his presidency that our science and math students shall rank "first in the world by the year 2000."

However, according to the American Institute of Physics, there is very little good data available on the current state of science education in the United States.

> In fact, good reliable data on the state of science education in this country are not easy to come by, and are scarcer than generally realized. On one hand an astonishing number of reports (one source has counted over 300 issued just since 1980) have raised the alarm over the parlous state of science education in this country. Yet, these reports base their conclusions on extremely restricted information, some of it of dubious quality, culled from the same handful of sources. We continue to have large gaps in our knowledge of what subjects our students actually take in high school, much less how much the really learn. Nor is there a definite picture of

> who is teaching those students, and what backgrounds and qualifications these teachers have in those subjects. (Neuschatz & Alpert, 1994)

There are, perhaps, many reasons for the lack of good data on the state of science education in our schools. To begin with, almost every individual school system in the United States is autonomous. That is, school administrators make decisions regarding curriculum, evaluation, and all other school related issues for their own school system. Considering that there are literally thousands of schools systems, it is easy to imagine that either regional or national standardization of practices is essentially nonexistent. In addition, since school systems are discrete organizations with individual definitions and views, data gathered and subsequently drawn conclusions may not be statistically useful.

Nevertheless, there have been several recent attempts to assess the state of science education in the Untied States. Some of those include <u>Report of the 1985-86 National Survey of Science and Mathematics Education</u> (Weiss, 1987), <u>Schools and Staffing in the United States: A Statistical Profile 1987-88</u> (U.S. Department of Education, 1992), <u>Study of Science I: Science Education and Curricula in 23 Countries</u> (International Association of the Evaluation and Educational Achievement, 1991), and <u>State Indicators of Science and Mathematical Education</u> (Council of Chief State School Officers, 1993). Reactions to the studies have been mixed, but many evaluators agree that the attempts have been limited and largely uncoordinated. In 1989, the American Institute of Physics in conjunction with the American Association Physics Teachers launched a nationwide survey which they hoped would help fill some of the gaps left by previous studies. The objective of the study was to

> . . . provide an in-depth look at secondary-level instruction in one key science discipline. By soliciting information directly from science teachers in the field, the survey aims to assemble accurate and highly focused data about a science field that tends to get "swallowed up" in studies that cover a broader sweep of subjects. (Neuschatz & Alpert, 1994).

The study is based on two surveys. The first was conducted in the fall of 1989 and surveyed a representative sample of principals from over 3300 school systems nationwide. The second was conducted several months later and surveyed teachers of physics from those same school systems. Findings were published in 1994 and suggest the crisis in science education, particularly in the area of physics, has been somewhat overstated. However, the findings do suggest that there are serious problems and concerns regarding the state of secondary physics instruction.

Some of the most disturbing findings of the study are as follows:

- Over four-fifths of all high school graduates have never taken a physics course. Of those students who do take physics in high school, 15 percent are female and only 10 percent are African-American or Hispanic.

- American students fare poorly relative to their foreign counterparts on comparative tests, giving rise to serious concerns over the level of instructional effectiveness.
- American teachers of physics face significant obstacles in trying to do their jobs effectively. The most frequently cited were lack of supplies and equipment and time pressures.
- Currently practicing American teachers of physics are generally less well trained than in the past, with only 18 percent holding a physics degree.

Clearly, there are many significant issues in secondary physics which need to be addressed. However, most issues fall into two basic categories. The first is low student enrollment in physics classes. Early studies indicated that approximately four fifths of all high schools in the United States did not offer physics as a senior elective. This would certainly lead one to conclude that the opportunity for many high school students to take physics was simply not available. However, these figures are somewhat misleading. For example, the 1989-90 AIP Survey (Neuschatz & Alpert, 1994) reports that many of the schools not offering senior physics, actually offer it on an alternating year basis with chemistry. Also, a substantial number of schools not offering physics are very small and account for an equally small percentage of students available to take physics. In fact, over 90 percent of all students in the United States attend schools where physics is offered. Nevertheless, only about 20 percent of high school students actually enroll in a physics course.

Obviously, the availability of physics in high schools across the United States is not a major factor in explaining the low student enrollment in physics.

The second major category is the level of effectiveness of physics instruction. The most recent High School Physics Teacher Survey was conducted in 1992-93 by the American Institute of Physics (Neuschatz, 1996). Part of that survey asked teachers of high school physics about their level of confidence in preparation and qualifications in four areas of physics teaching. In the area of Basic Physics Knowledge, 71 percent of teachers surveyed indicated that they viewed themselves as well prepared. Forty-two percent viewed themselves as well prepared in the Application to Everyday Life, while only 32 percent of teachers surveyed viewed themselves as well prepared in Laboratory Demonstration Techniques. Finally, only 16 percent viewed themselves as well prepared in Recent Developments in Physics.

These statistics underscore the need for changes in secondary physics instruction. As self-disclosed by physics teachers in the AIP Nationwide survey in 1989 (Neuschtz & Alpert, 1994), there are many obstacles encountered by physics teachers in their practice. Many of those obstacles are characteristics of school systems in general. Those obstacles include low student motivation, inadequate preparation time, and too many peripheral tasks. In fact, most obstacles identified by physics teachers are the same obstacles shared by their colleagues from other disciplines. And, it is not surprising that changes to such systemic issues are very slow in coming. On the other hand, there are issues which physics teachers face that can be addressed by physics teachers themselves with some outside assistance. In particular, the critical issue of physics teacher preparedness.

Physics has long been considered a fundamental science. That is, concepts and principles of physics are often the underpinnings of other sciences. In the 1989 report of the American Institute of Physics, Who Takes Science? (Czujko & Bernstein, 1989), a profile is drawn of students who have taken physics. Over two thirds are above average in the cognitive skills of reading and vocabulary. Students who have taken physics report having the highest grades while maintaining difficult course loads. Most are enrolled in a college preparatory curriculum and are more likely to take higher level math courses such as calculus. In addition, students who have taken physics report a high level of participation in extra-curricular activities. Moreover, these students are more likely that others to experience the full range of experiences that high schools have to offer.

While it is likely that students who have taken physics have also been high achievers before they enrolled in physics, it is also true that physics is an important step in remaining on the college preparatory track.

Apart from the relationship between enrollment in physics and overall high academic achievement, students who take physics place themselves at a distinct advantage over those who do no take physics. Many fields of study in college as well as career paths require a fundamental understanding of physics concepts. Career choices such a medicine, engineering, and environmental sciences, place an importance on physics. In the 1992-93 Bachelors Degree Recipient Report (Mulvey, 1995), other important aspects of taking physics in high school have been highlighted. "High School Physics is an important stepping stone to a degree in physics" and "The immediate post degree plans of physics bachelors are related to the educational background of the students prior to enrolling in a university that grants an undergraduate degree." Also, ". . . students who did not take physics in high school are more likely than students who did take a high school physics course to enter directly into employment upon completion of their bachelors degree."

Overall, it seems that by not taking physics, students are removing themselves from significant opportunities. Organizations dedicated to the advancement of science education have long since recognized the importance of physics in the high school curriculum. Over the past decade, many of these organizations have made proposals for sweeping change in how high schools teach science. Some of the most significant efforts include The Carnegie Corporation of New York, which proposed changes under a reform entitled "Turning Points"; the American Association for the Advancement of Science, which proposed benchmarks and goals for secondary science education in their Project 2061; and the National Science Teachers Association, which proposed a plan for Scope, Sequence and Coordination of Secondary Science. At the same time, science education standards were being developed on the regional, state, and national level.

Science Education has clearly come to the forefront of educational reform. It is also clear that teacher enhancement is a significant aspect of the reform effort. The investment made in improving science education has its obvious benefits and has been undertaken by many of the organizations mentioned.

In recognition of the need to assist secondary physics teachers, the National Science Foundation awarded $3.1 million in grant money to fund the UPDATE project at the University of Massachusetts in 1992. This is certainly typical of the kind of support offered to qualified programs in an effort to improve the science education in the United States. But, has the time and funding been wisely placed in teacher enhancement programs? This study may offer some insight into the value of the UPDATE program by exploring the extent to which participants of the program have altered their practices as secondary physics teachers.

In 1990, the Physics Department at the University of Massachusetts conducted its own survey of physics teachers. Approximately 250 physics teachers in Massachusetts were sent questionnaires specially constructed to determine program areas of interest as well as various possible models for meeting those interests. Results of the survey suggest a strong interest in the opportunity for teacher enhancement. Approximately 54 percent of the respondents indicated they were "very interested" in enhancement. This was followed by 24 percent indicating they were "very interested" in teacher certification in physics.

The topics which generated the most enthusiasm were "contemporary developments in physics" and "hands on use of equipment in class." These responses seem to corroborate previous and subsequent surveys such as the nationwide surveys conducted by the American Institute of Physics where Lab Demonstration Techniques and Recent Development in Physics were cited as what teachers were least prepared to teach.

In response to national surveys and their own survey, the University of Massachusetts launched a multi-campus program for physics teachers in 1992. Funded by the National Science Foundation, the UPDATE (University Physics Departments and Alliances for Teacher Enhancement) program was primarily designed to literally update or enhance both experienced and inexperienced physics teachers in topical and often neglected areas of the secondary physics curriculum.

The UPDATE program consists of two basic parts. The first part is a three-week summer institute. Teachers accepted into the program meet at one of the four University of Massachusetts campuses for two weeks of lectures and labs given by professional physicists and astronomers who are typically University faculty. The third week of the program is related but substantially different.

Participants from all four University of Massachusetts campuses converge at the Amherst campus for a week of lectures and related activities. The lectures are given by prominent scientists in a particular field of study. There are also supporting activities which take place both on and off campus. During this three-week period teachers are exposed to what to most is new physics and what to others are areas of physics of which they have little knowledge.

The second major part of the program takes place during the academic year. Teachers form study groups and meet formally six times between September and May. The purpose of the Academic Year Meetings is to provide teachers with the opportunity to work cooperatively to create classroom lessons from their newly gained physics knowledge. They create lessons and present their ideas to the rest of their group at their campus for feedback. Eventually, all newly created teaching units are collected and published by the host campus for use by all UPDATE participants.

Evaluations of the program have been conducted each year of the program. All evaluations have indicated the program has been very popular and highly successful in meeting its goals. For example, a questionnaire was administered by evaluators at the end of the summer institute in 1995. In part of the questionnaire, the goals of the program were stated and respondents were asked to evaluate the extent to which the program was successful in achieving its goals. This section was on a five-point scale. A score of 1 was highest, indicating "Very Successful," while a score of 5 was lowest, indicating "Very Unsuccessful." The goals as stated on the questionnaire and the average response scores are as follows:

1. Provide participants contact with professional physicists and astronomers.
   Mean Response Score: 1.6
2. Promote networking (reduce isolation) among physics teachers.
   Mean Response Score: 1.6
3. Provide opportunity for participants to learn new physics.
   Mean Response Score: 1.8

4. Provide opportunity for participants to enhance lab skills.

   Mean Response Score: 2.0

5. Provide new ideas for teaching physics.

   Mean Response Score: 2.0

In all cases, participants responded with scores from 2.0 to 1.6, representing a fairly narrow range from "Successful" to "Very Successful."

Clearly, participants felt the program was highly successful in achieving its goals. However, in terms of contributing to the national effort to improve physics instruction, the ultimately the worth or merit of the UPDATE program goes beyond the offering of intellectual stimulation and the gleaning of new physics knowledge. As indicated by national surveys, one of the major weaknesses of physics education in the United States is instruction. While teacher preparedness is an essential component of this weakness, simply enhancing knowledge does not necessarily translate to enhanced physics instruction. For example, a teacher who attends UPDATE may learn new physics, gain new contacts and generally like the program, but may not use or apply any of the UPDATE related material or ideas in his or her own classroom.

Therefore, although UPDATE has been highly successful, the effect of UPDATE on physics instruction is simply not known.

In view of this, the questions this study addresses are: 1. What impact has participation in the UPDATE program had on high school physics instruction?; and 2. What aspects of the UPDATE program are valuable in making contributions toward the enhancement of participants' high school physics instruction?

CHAPTER 2

EDUCATIONAL PROGRAM EVALUATION: A REVIEW OF THE LITERATURE

To many people, evaluation is a term with various meanings. In fact, for many years its definition eluded consensus, as several different definitions can be found in early literature. Confusion arose over several issues including whether evaluation should be considered research or simply measurement. One of the more prominent early definitions of evaluation was originated by Ralph Tyler (1950). He defined evaluation as "The process of determining to what extent the educational objectives are actually being realized." More than a decade later, Daniel Stufflebeam (1971) considered evaluation as a means of providing information for decision making.

These definitions gave rise to a group of models for program evaluation. The most widely used of these early models has its roots in the 1930s when Ralph Tyler conducted an eight-year comparative evaluation of some students from traditional and progressive high schools (Madaus & Stufflebeam, 1989). He saw evaluation as a necessity, and indeed an integral part of large scale curriculum development. Tyler conceptualized his model as a triangle. At the top (apex) of the triangle are objectives of the program to be evaluated. This is the beginning of the program development process. It states exactly what it is the participants are expected to know or be able to do as result of the program. The second angle of the triangle represents the program itself. It is the experience that is designed to allow participants to achieve the previously stated objectives. Finally, the last angle of the triangle represents the program evaluation. This is the process by which the evaluators determine if the program has met its goals. In other words, the extent to which the participants achieve the stated objectives (Madaus, Haney, & Kreitzer, 1992).

The Goals-Oriented model developed by Tyler (1950) and later promoted by Popham (1975) is very attractive in many ways, as discussed by Madaus, Haney, and Kreitzer (1992). First, it is common sense to ask whether a program has met its goals. It also requires the program to be clear about intended outcomes and holds the program personnel accountable for results. The approach is also is relatively unobtrusive, inexpensive, and provides easily quantifiable data. However, as appealing as this approach seems, it has several major disadvantages. Primarily, when a program fails to meet its stated goals, there is no way of knowing what went wrong. The model has no mechanism for identifying what aspects of the program were responsible for its success or failure. Another problem concerns the goals of the program. The model does not allow for criticism of the goals. Therefore, the program may very well meet its goals, but the goals themselves may be flawed. Also, some important aspects or outcomes of the program may go unrecognized if they were not subject to evaluation.

Finally, the goals-oriented approach yields information that indicates the success of the program after it is completed. The evaluative information is not available during the program to allow changes to be made to facilitate success. Michael Scriven (1967) was the first to make the distinction between these two roles of evaluation. He originated the terms formative and summative evaluation. In formative evaluation, evaluation is used for the improvement and development of the program as it is in progress. In contrast, summative evaluation summarizes the program at its completion which allows evaluators to measure overall success and to determine if the program should be continued. Both types of information are valuable to not only evaluators, but ultimately the stakeholders in the program. Stakeholders, as described by Robert Stake (1978), are persons who are affected by the program being evaluated, such as program directors or those who fund the program. Stakeholders, being heavily invested in the success of the program, find formative evaluation particularly useful as it allows them the opportunity to guide or modify the program while it is in progress to facilitate its success. Dereshiwsky and Packard (1992) distinguishes these ideas as "process" and "outcome." They also contend that while it is possible to determine a program as successful at its conclusion, it is also possible that activities that took place within the program were much less successful.

Due to the significant shortcomings of the Goals-Oriented Approach, another major model of evaluation emerged in the late 1960s. The Decision-Oriented Approach promoted by Alkin (1969) and Stufflebeam (1971) essentially suggests that evaluation should facilitate thoughtful judgments by program administrators concerning the program's merit (Stufflebeam & Shinkfield, 1985). This approach is concerned with three basic components of a program, inputs, processes, and products. Inputs are resources such as staff, facilities, publications and other physical needs of an educational program. Processes refer to the way the inputs, or resources, are used in the program and the nature of the participant's experience with the resources. Products are what the program produces. Like the Goals-Oriented approach, the Decision-Oriented approach provides quantitative information which is standardized and technically rigorous. Program policymakers, decision makers, and other stakeholders can use such information to look for clear cut cause and effect relationships between inputs, processes, and outcomes.

In many ways, the Decision-Oriented Approach was more advantageous for stakeholders than previous models. In this approach, the goals of the program themselves are subject to evaluation. While previous approaches attempted to determine the extent to which the goals of the program were being met, the Decision Oriented Approach provides the opportunity to examine and question the appropriateness or validity of the program goals. Other advantages include its adaptability to a wide range of evaluative purposes; it can serve program improvement, and is easily quantifiable. However, it also has major disadvantages. To begin with, it assumes that important decisions can be identified in advance and that the information gathered for the decision making process will be orderly, predictable, and properly used to inform decision makers (Worthen & Sanders, 1987). Another major disadvantage is that the needs of the decision makers drive the evaluation. Therefore, the scope of the evaluation can be limited and the needs of other audiences, such as the program participants, may not be accommodated.

Models advanced from the 1950s through the 1970s were nearly all designed to assist large scale curriculum development efforts and very important stakeholders such as the U.S. Government. Funding decisions and accountability were the most important outcomes of evaluations. The hallmark of these models was "scientific" data collection. Emphasis was placed on experimental methods, standardized data collection, large samples, and technical quantitative data. Along with these models came the general sentiment that systematic measurement that yielded "hard" data would demonstrate without any doubt whether a program was successful or unsuccessful (Herman, Morris & Fitz-Gibbon, 1987).

Following the first quantitatively oriented wave of evaluation models, a new wave of models emerged which are gaining popularity today. In the 1970s, criticism began to grow of traditional models as being insensitive and failing to capture what was really going on in many innovative programs (Worthen & Sanders, 1987). The dissatisfaction with the narrow paper-and-pencil technique to measure defined objectives gave rise to new approaches generally referred to as Naturalistic or Responsive. The Responsive Evaluation Model, pioneered by Robert Stake, was the first major attempt to evaluate programs in a purely qualitative manner (Stake, 1975). It also was substantially different from previous models in its evaluative approach. Most evaluative plans had emphasized preordinate aspects of a program, such as statements of goals and use of objective tests. However, the Responsive model is based on the observations and reactions of the evaluator(s). It is considered a more holistic view of program evaluation characterized by activities, transactions, and events that occur within the program (Madaus, Stufflebeam, & Scriven, 1983). This model assumes that programs are often complex and somewhat amorphous, not existing in isolation, but rather in complicated social and political settings. The focus of such evaluations is not fully determined in advance, rather they evolve throughout the program through observation, and interactions. Themes and issues emerge which all interested parties agree should be explored. Naturalistic models develop questions to explore on both sides of issues. Information gathered provides a rich and usually complex description of the program.

As documented in several sources (Marshal & Rossman, 1989; Krueger, 1988; Denzin, 1989; Patten, 1990), there are several typical ways to collect data in words, that is, non-numerical qualitative data such as descriptions or explanations in words. Typical methods of qualitative data collection include in-depth interviews (Stewart & Cash, 1982; Gorden, 1975; Weiss, 1975), direct observation (Galton & Delmont, 1975), document analysis, focus groups (Krueger, 1988), and in-depth case studies (Yin, 1989).

Naturalistic type evaluations have many appealing aspects. Lincoln and Guba (1985) point out several advantages not shared with more traditional, or so called "scientific" methods. Naturalistic methods usually provide in-depth information on what goes on in a program, they are excellent vehicles for formative evaluation, and they are problem- or issue-oriented. However, it is clear that such models have the major disadvantages of being very labor-intensive, time-consuming, and often costly. Also, the information gathered is not easily generalized or reduced to brief easily usable form.

Naturalistic or Responsive approaches are not only a new way of evaluating educational programs, but reflect a fundamental difference in the way evaluators seek an accurate picture of human experiences (Madaus, Haney, & Kreitzer, 1992). They require evaluators to rethink the question of data gathering. Questions of what kind of data should be gathered and for what reasons give rise to two great paradigms in educational research, often referred to as quantitative and qualitative inquiry (Borg & Gall, 1989).

Deciding on the nature of information to be collected in the evaluation process will ultimately drive the model or approach used in a particular program. Brikerhoff, Brethower, Hluchyj, and Nowakowski (1983) suggest there are four kinds of information typically collected: information needed to decide on goals, to determine strategies, to determine implementation, and to determine whether the program should be recycled or continued. A number of other prominent researchers (Berk & Rossi, 1990; Kettner, Moromey & Martin, 1990; Patton, 1990; Rossi & Freeman, 1989) would reduce program assessment into two fundamental questions:

1. Was the program executed according to plan?
2. Did the program lead to the desired outcomes?

However, it is important to note the difference between these two questions. Derishewsky and Packard point out that a program can "run by the numbers" and yet fail to produce the target outcomes for which it was designed. Kettner, Moroney, and Martin refer to this phenomenon as "theory failure" versus "program failure."

Others, such as Patton (1990), indicate "Numbers convey a sense of precision and accuracy even if the measurements that yield the numbers are relatively unreliable, invalid and meaningless." Furthermore, Dereshiwsky and Packard (1992) state,

> Indeed, when properly applied, statistics may tell us a great deal. The problem lies in using them for the wrong purpose, as well as failing to recognize what these elegantly simplistic statistics are not able to tell us.

Yin (1989) goes further, indicating that qualitative data can provide an in-depth understanding of key elements of a program which contribute to the success or failure of a program, while quantitative data provide only a single and sometimes overgeneralized numeric indicator.

Some researchers, such as Eisner (1992) and Mariampolski (1984), hold the view that the essential benefit of qualitative information over quantitative information is that it simply yields more in depth information. However, by far the fastest growing population of evaluators and researchers, such as Brewer and Hunter (1989) and Reichardt and Rallis (1994), argue that the combination of qualitative methods and qualitative methods is superior to either one alone. Jacobs (1985) puts the arguments into perspective:

> It should be noted that there are no criteria or guidelines available to select one inquiry paradigm over another for a particular problem. In practice, training and development professionals must be responsive to many factors when collecting information in their settings, such as the goals of the inquiry and the information requirements of the organization. As

> a result, the consideration of which approach to the inquiry is most appropriate has been based primarily on professional judgment.

It seems clear that the two major paradigms of educational inquiry, that is quantitative and qualitative, each have major advantages and disadvantages. Quantitative inquiry has been the standard to which all others are compared. Although it is very narrow in scope, it is simple, inexpensive, and it can indicate overall success or failure of a program to meet its goals. Qualitative inquiry is labor intensive, expensive, and does not yield data which is easily summarized. However, it can provide rich, in-depth information about the experiences and perceptions of those associated with a program. Choosing a method of inquiry depends on several factors. The first and most important is what is really needed to be known. Madaus, Haney and Kreitzer (1992) point out that all of the approaches to educational evaluation differ only in scope of the inquiry, or how wide the net of evaluation questions is cast. Certainly if all that is required is to determine whether a program met its goals, the choice of a quantitative method appears obvious. On the other hand, if the success of the program is indicated by the quality of the participant's personal experience of the events within the program, the only way to find out is through interviews and observation.

In my view, given the time and resources, one cannot argue with using both methods to gather the maximum amount of information. Such an evaluation would have the benefit of developing a body of knowledge that includes the richness and depth of qualitative inquiry as well as the focused, manipulable quantitative data which can suggest cause and effect relationships. This "new" methodology is currently known as "multimethod research," although earlier researchers such as Denzin (1978) and Jick (1979), referred to this idea as triangulation.

`As Brewer and Hunter (1989) point out, the fundamental strategy of this approach is to "attack a research problem with an arsenal of methods that have non-overlapping weaknesses in addition to complementary strengths." The problem is that programs and evaluative situations are rarely ideal. Commonly, programs operate on limited resources. Funding may not include evaluation, or time may not be built in to the program for evaluation. Also, program directors and stakeholders may not agree on what determines the success of the program.

There are many possible responses to such situations. For example, Guba and Lincoln (1981) suggest, the client and evaluator might contractually agree on what exactly is to be evaluated and what will be the purpose of the evaluation. In addition, it is important to identify the resources available for evaluation. Such resources include the costs of evaluation and the time frame involved in both the program and the evaluation. This information is invaluable in determining the nature of the evaluation.

CHAPTER 3

THE UPDATE PROGRAM

The UPDATE (University Physics Departments and Alliances for Teacher Enhancement) Program is a three-year program funded by the National Science Foundation. Each year of the program has followed a fairly consistent sequence of events as designed primarily by Amherst campus professor Leroy Cook, principal investigator of the NSF grant and the program director. The year begins in the fall with planning meetings. The directors of the physics departments from each of the University of Massachusetts campuses, as well as prospective program lecturers and laboratory instructors meet over several months in an attempt to lay out the upcoming UPDATE program. Agreements are made on format, subject matter, level of difficulty, lectures, laboratory experiences, and activities. At the conclusion of the planning meetings in late spring, each campus is prepared to conduct the UPDATE program at their own site, with the promise that the experiences offered to participants will be fairly uniform across campuses.

During the course of the winter, mailings advertising the UPDATE program are sent to all school systems in Massachusetts as well as to many individual physics teachers. Each campus allows up to 24 teachers from its region to participate, for a total of 96 participants for the program.

The program begins at each campus at the same time, at a predetermined date in the beginning of July. Participants spend two weeks at their respective "home" campus attending lectures and conducting laboratory experiments. Many of the laboratory activities are conducted with high tech equipment not usually available to high school teachers. In addition, participants are given a Resource Kit which includes laboratory equipment that they may take back to their respective schools. Lectures and laboratory activities are typically conducted by University faculty. Each campus site is free to design its own schedule of events. At the conclusion of the first two weeks of the program, participants from all campuses meet at the Amherst campus for the final week of the summer component of the program. Campus housing is made available for all participants. However, participants associated with the Amherst campus usually do not stay on campus as most commute from nearby towns.

During the third week of the program, participants are offered a variety of activities related to the topics under study that year. Lectures are offered by at least two prominent figures in the related fields of study. Lab activities are offered by University faculty to augment previous lectures and lab experiences. In addition, field trips of outside activities are offered.

At the conclusion of the entire three-week summer institute, teachers leave to meet again in September to begin the final component of the UPDATE program.
The final component of the program consists of six formal meetings, which take place at each campus. The meetings usually take place in the afternoon, evening, or on Saturdays, and are scheduled from September to May at the discretion of each campus director.

The primary purpose of the Academic Year Meetings is to allow participants to collaborate in small groups to develop lessons or activities related to UPDATE material that can be used directly in the high school physics classroom. At the conclusion of the Academic Year Meetings, these teaching units are collected and printed for distribution to all participants.

Throughout the UPDATE program, evaluators gather data by direct observation, questionnaires and informal interviews. Each of the two evaluators attend and make observations of all aspects of the program. Questionnaires are given at the beginning of the three-week summer institute, at the end of the three-week institute, and at the conclusion of the Academic Year Meetings, which mark the end of the year's program. In addition, informal interviews are conducted throughout all parts of the program. All data collected are shared with program administrators, who then use the information to make desirable adjustments in the program to maximize the participants' experience. Therefore, the program has a continuous means of self-improvement so program goals can be met with a high degree of success. In fact, each year of the program has been highly successful as indicated by data collected through the means previously noted, and each year has seen improvement over previous years.

CHAPTER 4

METHODOLOGY

In designing a methodology to determine the extent to which participation in the UPDATE program has affected the physics instruction of its 1995-96 participants, it was necessary to establish specific objectives of the study. Once specific objectives of the study were established, methods of data collection were then selected to meet the objectives.

There were several parameters of the program as well as individual aspects of the participants that may have contributed to instructional change. To begin with, the program took place in both a "home" campus, that is the campus with which an individual participant was associated, and the Amherst campus where the third week of the summer program took place. Since each UPDATE campus site director established individual schedules and University faculty and facilities vary from campus to campus, the experiences of each of the four UPDATE groups may have been different.

The third week of the summer program took place at the Amherst campus. Participants from campuses other than Amherst resided at the Amherst campus for that week. The experience of residence and UPDATE activities that were conducted, at least in part, by University faculty who were not familiar, were also variables which may have affected the UPDATE experience. Finally, the academic year component took place at the participant's "home" campus.

The experience was significantly different than the summer institute, as the focus of the Academic Year Meetings was collaborative work in development of lessons and activities for classroom use. Obviously, the experiences at each campus were unique and may have been a factor in the effect of the program on instruction.

Other variables which needed to be considered in the study include characteristics of the participants. For example, many of the participants were "veteran" physics teachers and have had several years of experience teaching physics. Others were beginning teachers and considered themselves "inexperienced" as physics teachers. Teaching style was another important consideration. Although the UPDATE program was designed to enhance physics teacher knowledge through lecture and labs, it also promoted a hands-on, laboratory-oriented approach towards teaching secondary physics. Laboratory knowledge and skills enhanced by the UPDATE program lend themselves to the use of constructivist approaches to physics teaching. It is then possible that the UPDATE program may have affected the instruction of those teachers whose teaching style was oriented toward constructivism differently than those teachers whose teaching style was more traditional, or less oriented toward constructivism. In addition, approximately 15 percent of the participants were female. It has not been established whether females as a gender group had significantly different experiences in the UPDATE program than did their male counterparts.

In summary, it was useful to collect data regarding individual participants' view of the program in terms of their "home" campus experience, including the summer institute as well as the academic year component. Also, their experiences at the Amherst campus during the third week of the summer institute component were a significant part of the overall UPDATE experience and may have been a factor in affecting instruction.

Although the UPDATE program as a whole shared a common philosophy and objectives, each campus clearly offered a potentially unique or different experience to participants. Therefore, participants from each campus may be able to offer a unique perspective of the program and its effect on their instruction. To that end, a group interview with participants from each campus would be useful in painting a more complete picture of the UPDATE program. In view of this, four focus groups were selected and interviewed. Approximately four participants from a particular campus were selected to form a focus group. The participants for each focus group were randomly selected from the group of teachers attending each campus who have participated in UPDATE for more than one year. At each campus, approximately 50 percent of the teachers had participated in the UPDATE program for more than one year. Therefore, the population from which a group of four were randomly selected at each campus, was approximately 11 participants. The result of this selection meant that approximately half of the target population of were participants in the study. Selection of this particular "veteran" sample allowed a broader perspective on the program and a greater ability for the identification of program characteristics important to instructional change. Another advantage of a campus focus group is the familiarity among the members of the group. Unlike an individual interview, in a focus group interview, participants often feel a sense of comfort with each other that promotes conversation and discussion of new ideas. The focus group format also promotes an atmosphere where a participant might be prompted by a statement of another participant or add to an existing conversation or comment, producing information that is sometimes unanticipated and very valuable to the researcher. Therefore, the focus group data was useful in identifying not only what participants' found valuable about the program, but also the "burning" issues hat existed at each campus.

The format was semi-structured. That is, a set of broad questions was asked of each focus group, but the interviewer allowed the conversation to expand beyond the confines of the original questions. This format allowed the interviewer to collect a uniform set of data regarding a predetermined set of questions, as well as collecting information of a more spontaneous nature. The interviews were audio taped and transcribed.

In all, the focus group provided a sense of the broad issues and feelings towards the program and its effect on physics instruction. Identification of such issues and information was an important first step in understanding the possible effect of participation in the UPDATE program on physics instruction.

After the broad issues, concerns, and feelings about the UPDATE program and its effect on physics instruction have been raised and focused in focus groups, a deeper exploration of these issues was then possible through individual interviews. In this format, the participant and the interviewer had the flexibility to explore important issues more broadly and deeply than was possible in focus groups. Therefore, the data collected from all four focus groups was used to construct individual interview questions. Possible concerns to be explored included the specific use of UPDATE material and ideas used in the classroom. Questions were also be asked about the various aspects of the UPDATE program and what specific influences had come out of the UPDATE experience.

One participant from each of the four UPDATE sites was selected to be interviewed. The participants selected were drawn from the entire population of UPDATE participants at each campus. The interviews were audio taped and transcribed.

Although interviews have important advantages over other methods of data collection, they have limitations as a research tool. The flexibility, adaptability, and open-endedness of interviews, which are often considered strengths of interviews, may also be weaknesses, as they allow a degree of subjectivity and possible bias from several sources. Also, since there are a limited number of interviewees in this study, it is not possible to say with any certainty that views, concerns, and issues identified in interviews are shared by the general population of UPDATE participants.

In view of these limitations, a complimentary method of data collection took place by a specially designed questionnaire, administered to all UPDATE participants which served to determine the extent to which issues, concerns, opinions, etc., identified in focus groups and more deeply explored in individual interviews, were held by the population of UPDATE participants. Therefore, the data collected in both focus group and individual interviews were used to construct many of the questionnaire items.

Another function of the questionnaire was to establish a baseline of information about the UPDATE participants such as teaching experience, teaching style, and gender. Other items were designed to solicit participants' views on all key aspects of the program, including strengths and weaknesses. The questionnaire was closed in form, permitting certain predetermined choices to items. The closed form questionnaire lends itself to quantitative data analysis to a greater degree than an open-form questionnaire allowing possible correlations to emerge. The population of the questionnaire was the entire group of 93 Year-3 UPDATE participants. The questionnaire was administered at each of the four UPDATE campus sites during one of the last Academic Year Meetings. Administering the questionnaire during this time maximized participation and still allowed participants to have the full UPDATE experience necessary to complete the questionnaire.

During all three years the UPDATE program was in progress, it was continually monitored by program evaluators. Interviews with participants were held throughout each year and questionnaires were administered approximately twice each year. All of this evaluation data was used to keep program administrators informed so corrections or adjustments could be made to maximize the experiences of the participants. The other use of the evaluation data was to provide stakeholders with information about the perceived worth of the program. However, an added benefit of the evaluation data was the substantial data base from which subsequent interviews and questionnaires were based. Participant concerns, general issues of program schedule and management, academic rigor, and pedagogical issues were only a few of the many aspects of the program discussed in interviews and inquired about in questionnaires. Each year new evaluation tools were constructed based on previous findings resulting in substantial interplay between evaluation tools and methods.

The construction of the Focus Groups questions, therefore, was part of that interplay. Since the Focus Group interviews took place in the final year of the UPDATE program and the participants in the Focus Groups were primarily veteran UPDATE participants, previous evaluation findings strongly influenced the construction of Focus Group interview questions.

Questions for the Focus Group Interviews were constructed to elicit information in four basic areas. First, general questions about the UPDATE program in previous years were asked which allowed participants to raise concerns about the Program from their experiences participating in UPDATE over more than a year. Secondly, some questions were constructed to identify what the participants found valuable about the program. Thirdly, questions were asked about the participants' personal secondary physics instruction and any possible changes that may have occurred since their participation in the UPDATE program. Finally, participants were given the opportunity to discuss any outcomes of the UPDATE program which they felt were unexpected. Unexpected outcomes identified by participants were used as indicators of important aspects of the program of which the researcher was unaware.

The names used in the transcriptions are not the real names of the participants.

Limitations of the Study

The research design of this study can be classified as generally descriptive. Descriptive studies are primarily concerned with finding out "what is" (Borg & Gall, 1989). Although causal relationships may emerge from this study, for example what program factors determined the level of instructional change, this study is primarily concerned with describing the changes, if any, in physics instruction of UPDATE participants due to their participation in the program.

As discussed earlier, each instrument used has its limitations and potential sources of error. To minimize error and maximize useful data, the research design used a combination of quantitative and qualitative methods in an effort to compensate for the weaknesses of each. However, the variety of research instruments notwithstanding, there are inherent limitations to this study.

The most significant limitation of the study is that the data collected were entirely self-disclosed information offered by participants. Such information, particularly as collected in interviews, is subjective and open to bias. The interactions between researcher and respondent may be affected by several factors. In what is generally called the "response effect," respondents may give inaccurate or incorrect responses to the researcher. For example, bias can come from the eagerness of the respondent to impress the researcher, or the respondent may be ashamed or regretful for not meeting an expected level of accomplishment. Both cases may possibly lead to exaggerations, understatements or misrepresentations.

A second significant limitation is the selection of the interviewees for both the focus group interviews and the individual interviews. Both focus group and individual interviews provided a small selected sample of data. This may have affected the external validity of the findings. That is, the degree to which the findings can be generalized to the entire UPDATE population may be limited. In an attempt to maximize external validity, the interviews took place at each of the four UPDATE campuses, as data collected at several sites enhanced the probability of external validity (Goetz & LeCompte, 1984). Selection for the focus group interviews was made from the members of each UPDATE campus who have participated in the program for more than one year. Such "veteran" teachers should have had more of a holistic view of the program than those teachers who have participated for only one year. They were more likely to be able to identify those aspects of the program which have been valuable in promoting instructional or curricular change. However, exclusion of Year-1 participants removed the focus groups from being completely representative of their individual campuses as well as of the UPDATE population as a whole. Nevertheless, the focus groups were representative of the "veteran" population of UPDATE participants, which was approximately fifty percent of the overall Year-3 population.

The teachers selected for individual interviews may also not have been representative of the population of UPDATE participants. These individuals were randomly selected from the entire group at each campus. However, since permission was sought from participants at each campus, those who agreed to be interviewed may not be representative.

The questionnaire component of the study may also have provided sources of error. For example, the questionnaire data is limited in scope by its rigid nature and may inadequately represent the actual feelings of the population of participants.

CHAPTER 5

FOCUS GROUP INTERVIEWS

The following four Focus Group Interviews are presented *verbatim*. A summary of each Focus Group interview can be found at the conclusion of the interviews. The set of questions used in the Focus Group interviews was used as a general structure. The semi-structured nature of the interviews allowed considerable flexibility. Questions, and in some cases entire discussions, appear in the interviews which were not among, or associated with, the predetermined set of questions. For the reader's convenience the predetermined Focus Group interview questions follow. They also can be found in Appendix D.

The names which appear in the Focus Group interviews are not the real names of the participants.

Focus Group Interview Questions

1. What are your feelings about this year's program at your home campus in terms of level of difficulty, pace, and appropriateness of topics?
2. What are your feelings about the 3rd week at Amherst so far?
3. Has the program changed since you first participated? In what ways?
4. All of you have participated in UPDATE for more than a year. Can you discuss why you chose to participate again?

5. Has the program affected your teaching? If so, in what ways?

6. Has the program affected or influenced your physics curriculum? In what ways?

7. What do you think were the most important things you gained from the program?

8. I would like to read you the goals of the program. Please comment on whether you think they are appropriate, and the extent to which you think the program succeeded in meeting its goals.

   a. Provide participants contact with professional physicists & astronomers.

   b. Promote networking (reduce isolation) among physics teachers.

   c. Provide opportunity for participants to learn new physics.

   d. Provide opportunity for participants to enhance lab skills.

   e. Provide new ideas for teaching physics.

9. Do you think your participation in UPDATE had an effect on your physics students? If so, in what ways?

10. What would you like to have received from the program that you did not receive? Did the program disappoint you in any way? If so, how?

11. Were there any unexpected outcomes or effects (surprises) you experienced as a result of the UPDATE program? If so, what were they?

12. What are the characteristics of this program which should be characteristics of future or subsequent programs?

13. Are there any other issues or concerns you would like to discuss?

<u>Amherst Focus Group</u>

Researcher	What are your feelings about this year's program, such as level of difficulty, pace, appropriateness?
Alan	I think the big thing is pressure. I feel a lot less pressure this year. More time to relax in between. Probably a function of the labs we had last year. I think that would be the biggest thing.
Kate	I agree, it gives you a lot more time to interact with the other teachers and assimilate what you are learning and then come up with some applications you're going to use in your classrooms.
Carl	I like the extra time because it gives you a little time to reflect, either with other teachers or by myself to sit down and think about a few things, before we go right into something else.
Dorothy	I think the labs were much more relaxed this year which made it easier for me because last year I felt really tense about trying to get everything done and make sure I knew exactly what I was doing, and there was more time to kind of talk to other people and it wasn't as quantitative so we were looking at things qualitatively and seeing how to set things up and that was real helpful for me.
Rob	I would have liked to see a couple of technical things discussed in space flight

that were never brought up, like gyroscopes and how to use them.

Allan — Right. That's probably a problem between broad general subjects, because I feel the same way. Perhaps I'd like to see something like, radio controlled airplanes. I'm interested in stability, maybe other people are not. But within any given area, you could have some subtopics. But obviously it would be up to the individual instructor, whether or not that person feels comfortable with the subtopics.

Researcher — How about the appropriateness of the subject? It seems people like the space physics, but what about the quantum? Is that useful for this year?

Rob — Oh yeah, definitely.

Dorothy — It was really useful for me because I do a lot of that in chemistry. When I talk atomic structure. So the little bit that Roy did on the bonding was really nice because he got in a couple of things I hadn't thought of at least to explain things. I tried to explain those things, but sometimes I feel I don't do very clearly. Now I have a new way to try that and I hope it works better. I found the stuff really useful.

Rob — I think Roy did a good job.

Allan — I'll second that. I think Roy did a great job, and again that was the most important thing to me, because I do teach some chemistry and I feel a little uneasy. Particularly with a subject like metallic form. Now I have some idea why those valence electrons are running around through that metal, and quite frankly it was magic before. I really didn't know why.

Rob — That was the one thing if I walked away and I said gee now I understand this.

Researcher — What about the third week, how are you finding the third week?

Kate — I was hoping that we would have had more applications of quantum mechanics that we could point out to our students. You know,

	where does it make a difference in that everyday technology that they're going to be exposed to. And I think that's one thing that would have been nice to have.
Carl	Field trips last year, with the applications as part of the field trips was big for me. But I don't know how you would have put it in, other than go to a hospital and talk to someone who uses the MRI or Cat Scan machine or whatever. But certainly I know UMass Boston teaches a physics course that is based around that sort of thing, the applications. So I got to believe the resources are out there. But that's how you sell the kids. What do you use this for, what are the applications.
Rob	Where is this going to be used?
Allan	Exactly.
Kate	To follow up on that, I think it's been very inspirational, which is suppose to be a part of this. The astronauts have been fantastic. And, uh, we still have quite a bit of the other sessions. We had the last sessions, our particular group, but those were kind of what we normally expect in the second week, sort of a summary of that, so we still have a couple of things we haven't seen yet.
Researcher	Everyone here is a veteran, you've done this before, how's the program changed since you first got into it?
Dorothy	It seems a little more relaxed this year than it did last year.
Researcher	In what way?
Dorothy	One is time constraints I think. And it may be just a function of this being the second year and so you know the people better. It just seems like there are relationships and it's easier to talk to people, and that is a part of any program I think.
Allan	That's the benefit of coming at least two years, that you do cement some relationships. You know in my case, I'm part of the science department but I'm the only physics teacher so unlike English teachers

	in my school where twelve of them to talk to each other, I don't get a lot of opportunities to talk to other physics teachers.
Carl	I don't recall the break time being as great a time either. It really seemed like last year we went from one thing directly to something else. It really sometimes short circuited the labs to get to the lectures on time. This year having that half hour leeway time, means if you are still interested you can sit down and be interested, or you can go take a break and come back again.
Kate	I think overall there's been a progression of camaraderie that gets built up with the University faculty and the teachers, and it really is more of a team. I'm not sure whether some of the sessions during the year, where people sharing their ideas has helped to do that. Uh, but I feel certainly compared to some things going on ten years ago, that it's much more of a professional team. We're helping them, they're helping us.
Allan	Absolutely. I mean, I've never had a problem selling the University to my students but I think that I feel more aggressive about that now, particularly when you hear a put-down of the state university system. It's unjustified.
Researcher	This is related question. Everybody here is a veteran of UPDATE, can you give me a sense of why you came back?
Allan	I had so much fun last year. I really did. I'll honestly tell you that when it ended there was a let down. I said 'Gee, what am I going to do?' (chuckle) I'm not going to have to get up at six o'clock in the morning anymore. I really enjoy it.
Carl	Fun was the biggest factor and then just knowing other people. And, knowing during the year you're going to spark other ideas again. And the stipend helps.

Rob	Just the idea of getting projects or demonstrations, getting an idea for one, or getting somebody presenting one. That is a great resource.
Allan	Yuh.
Dorothy	Another thing that really made me want to come back was the idea that we were going to do some work on quantum mechanics and that was something I was really interested in and wanted to see how I could integrate that more into my classes and that's not something you can get from very many places.
Allan	I don't want to downplay the pay. Getting paid to come is certainly a plus. I'm one who would have come if I wasn't getting paid but getting paid is certainly nice and getting six graduate credits is part of it as well.
Researcher	Do you think the program has affected your teaching? And how so?
Dorothy	It's made me feel more comfortable doing demonstrations and things that I didn't do before. That was probably my weakest point when I came in and I feel much more comfortable doing that, and if it doesn't work, sometimes they don't work when we do them here, so that's OK.
Kate	I interject a lot more creativity because the opportunity to talk with other people about how they do a particular topic in a different way, or even the same demonstration you do with a little bit of a different twist, uh, it sort of shakes you up and jolts you into a higher level of being involved. Let's try something new. I think about it a lot during the year as I'm going through it. If I had additional preparation time, I would have incorporated in even more things.
Allan	Sure.
Kate	But building some of the apparatus takes time.
Allan	I think it also reaffirms what you're doing in you're own classroom, seeing these hundred other teachers and they're basically

doing similar things. You know you're not out on a limb, you're not operating in a vacuum and that's important. Teaching physics you can sometimes feel that way.

Researcher Well, usually most schools only have one physics teacher.

Rob Exactly.

Researcher And sometimes those people aren't full-time physics either, they just teach one or two classes, so it is isolating. Have you changed your curriculum because of UPDATE, in what you include and in what you don't include?

Allen In my case, just before I did UPDATE, I had done the PRISMS Program and that kind of got me back into much more lab orientated set. I think had I not done that first UPDATE would have been the thing that would have gotten me back. Prisms I think was an excellent program, in terms of lab orientation.

Researcher What about the rest of you, have you included more UPDATE topics, or spent more time on UPDATE topics, or not?

Dorothy I spent more time on electricity and building circuits and stuff because after we did all that work last year on the circuit boards and everything, I felt much more comfortable about how to do that and how to troubleshoot. Like when a kid had something set up and it wasn't working right. And that was something that before I was really careful about and really did a lot more hand holding and watched what they did more closely. Now I kind of let them go and mess around a lot more.

Carl I think last summer's labs had more effect on my physics labs, then this year's will on next year's labs. Because a lot of the labs we did in quantum mechanics, the wave tank sorts of things, that I already do. Or, they were things that I couldn't do like the microwave things would be impossible to do.

Researcher	Let me ask you to sort of put this all together and tell me what some of the most important things that you've gained from the program have been? The most important things.
Kate	I'd say the number one most important thing is meeting the other physics teachers in the program.
Dorothy	Absolutely.
Allan	I would agree. Yeah.
Researcher	So the camaraderie really helps?
Rob	Camaraderie is very important. Yeah.
Researcher	You may not be aware of the goals of the program but the program directors have indicated there are five goals. I'd like to read you those goals and I'd like you to comment on whether or not the program has met its' obligation to those goals. And any kind of comments you want to make about that are appreciated. The first one is to provide participants contact with professional physicists and astronomers.
Allan	Definitely on that one, yup, no question.
Researcher	The second is to promote networking, to reduce isolation among physics teachers.
All	Yup, yup.
Researcher	The third is to provide an opportunity for participants to learn new physics.
Dorothy	Yup.
Carl	Not as strong but certainly met that.
Allan	Not as true but definitely met that.
Kate	I think that varies depending on the topic and personal experience.
Allan	See in your case it was the electricity, in my case it was looking at that little pin demonstration that we saw yesterday I said

	gee I would never do that on my own, but now I'm going to do that one.
Dorothy	And I also, I mean I'm not really physics certified and I kind of picked up physics because I was, they needed someone else to do it and I was kind of qualified, so I've really learned a lot when I come to this because I haven't had a lot of this stuff, so it really depends on your background too.
Researcher	OK. The fourth one is to provide an opportunity for participants to enhance their laboratory skills.
All	Yeah, I agree, yes.
Researcher	Everybody agrees?
All	Yes.
Researcher	And the last one is to provide new ideas for teaching physics.
Kate	I think that's way up there.
Allan	That's way up there.
Kate	Way way up there.
Researcher	There has been sort of a, of a debate about this program. Some people have said that this program is primarily for teacher enhancement, and then there are those people who say that this program should really be about learning new teaching ideas. Can you respond to that?
Carl	I think that's where the demos come in. I think the demos help us to get new ideas. But we are certainly getting enrichment.
Kate	But the break time and the less structured lab period I think have provided us with a huge amount of time to brainstorm. Just people overhearing conversations, oh well you can do it this way or do you have this laying around and uh, why don't you try that. I think that's a very valuable part of meeting the other teachers.
Allan	One thing that hasn't come up that I just thought about is the cross-section of physics teachers. I mean working with

someone who is a first year teacher all the way up to someone who's a couple years away from retirement, that is very good, that mix is good. You realize there is another generation of teachers coming in, that are very qualified and are going to replace us all some day, since I'm on the down end.

Dorothy — Yeah, I think this program has done both. More enhancement for me. Not so much new ideas.

Researcher — In the beginning there was a distinction between inexperienced and experienced teachers and now there's really no distinction. Do you think that was a good idea or a bad idea?

Rob — I think it was a good idea to lose that distinction. I think you make the first year teachers feel like they're separate, not good enough.

Allan — That was only the first year, right?

Researcher — That was only the first year.

Allan — I heard about that and I was surprised they did that.

Rob — I didn't like that and I didn't think it was constructive.

Researcher — Why didn't you like it ?

Rob — Yeah, well because you were just isolated and you were supposed to come up with some lab activities. I don't know. At the end of two weeks, I wasn't really prepared to come up with lab activities.

Researcher — Do you think your participation in UPDATE has affected your students?

Carl — I think the enthusiasm that I have comes back to them. The more enthused I can be about a subject, the more enthused they are and by doing UPDATE, I'm more enthused about doing physics than I use to be.

Dorothy — I agree, it's sort of like going to meetings and you come back and you have new ideas and you're charged up to do it but it's spread out over a longer period of time and although we sometimes complain about fitting those meetings during a school year into our schedule, I think they actually effectively help us to carry that on through the year.

Rob — Keep up the momentum.

Carl — Oh absolutely. It's good to get away and come out and see everything.

Researcher — Was there anything in the program that you didn't get that you would have liked to?

Allan — One issue would be the Resource Room. People really want access to a Resource Room. At some of the other schools it's been up and running and they have stuff for this year. I mean we really seem to be lagging on this campus on our Resource Room.

Rob — I would have questions whether the Resource Room even if it was running if it had any value at all for 90 percent of the people.

Carl — It's too far away?

Rob — Actually coming up here and getting stuff. I won't come up here.

Researcher — Too far away?

Rob — Yeah. I think the money would have been better spent to have every teacher every year have a couple extra two hundred dollars and go out and buy this and this for each school. Buy extra lab equipment. I just don't see it as a viable resource except for a few people.

Allan — See, I have mixed feelings. I will come up to do the liquid nitrogen and if I didn't know the Resource Room was there I probably wouldn't get on the telephone and call someone in the department and say "hey, can I come up and get some liquid nitrogen," but knowing it's there, I'm going to come. But that would probably be about the only time that I would presently come for. Yeah it's a distance for me.

Researcher — Are there any other things that you wish you had gotten out of the program that didn't happen?

Carl	A minor detail but something I'd like to have from last year was David's notes from those lectures which we don't have. Well we got the first couple but after that we didn't and they're nice to go back and refer to.
Researcher	You're going to get those eventually. How about surprises or outcomes that you didn't expect, thinking about your whole experience here?
Allan	I think I was surprised that I could be entertained, a bad word, for this long a period of time. But, uh the day goes by pretty fast and like I said I am tacking on an hour and ten minutes on either end. I am tired when I get home and there are times Ron and I get back to Charlton and say gee if we ever do this again it's got to end at three or end at four.
Researcher	Anyone else on that subject?
Kate	I was surprised by what I thought was a really good job Roy did with the quantum mechanic's lectures, because that's a difficult topic.
Carl	Yeah, that is.
Kate	And I sort of had some qualms about how valuable those lectures would be.
Dorothy	And that's true, I think a lot of us were a little concerned about where Roy was going to start, because I remember when we came to the institutes a few years back he did a final lecture on particle physics and I just remember all of us sitting in the audience going "whoosh", you know, just being totally blown away. So I was a little nervous about where he was going to start and where he was going to take us, but I think he did a really good job.
Researcher	How about the Academic Year sessions, what do you think about those?
Rob	Too long ...three hours.
Researcher	Too long to get there or too many of them or both?

Rob — No, too many hours per meeting.

Dorothy — It would probably be more beneficial if, um, that time could be used for the groups to work. I know, I worked with Pat and Paul last year. Pat and I teach in the same school and so we had already kind of talked and said well, do you just want to do a two-person group this year because it will be a lot easier for us to collaborate, cause it was so hard even though Paul was just in the next town for the three of us to get our schedules to mesh to do a group project. I don't think we did a group project, we each did kind of a little project and I kind of got the idea in the beginning, and even this year when Klaus was talking about projects, um that it was supposed to be more of a group thing than everybody doing a separate little . . .

Allan — Is that universal? Because I feel the same way. I don't think group works. I mean Ron and I live in the same town . We live within a mile and a half of each other and we still had a hard time getting together, we did it on the telephone a few times.

Carl — It would be nice to do that for an hour, to have some sort of instruction, to have some guest speaker talk because I thought the three hours or four hours or whatever it is, there's a lot of this kind of dead. Let's fill in this timeline and so people would drag things out because they knew they could eat up time. Whereas if somebody lectured, somebody else from the University some place came in for an hour, have an hour of just discussion and questions or whatever and then go into the demos and the projects, would be a good idea.

Dorothy — Like people were just commenting about real uses of quantum physics. That would be a great topic, if someone could come and talk for an hour and just give us some specifics so we could go back and say to the kids, OK. this is what I did this summer and here's a real life application.

Allan — One of the things we mentioned, like uh the electron nature of the metallic bond. Roy saying I really don't have enough time to go into this, well, here's your chance. So we could uh, talk about some of those things in space physics, I'm sure David said, "how about electron gyroscopes and how they are used?"

Carl	And if he knows he is going to be the fifth lecture, he has plenty of time, I mean from this meeting then he has plenty of time to do it. And then each individual campus could focus in on those, so that if our campus had different five or six things they wanted to do, while Dartmouth could do six different other things.
Kate	Or the other thing, since they really didn't do the field trips this summer and a lot of that stuff has to do with hospitals and some of their equipment that they're using, it might be nice to use one of our meeting sessions, before we're at the point where we're going to be reporting back on projects and so on, uh to just meet some place and tour a facility and find out about it.
Dorothy	That's a good idea.
Researcher	Thinking about future programs, can you talk more about those things that are characteristics of doing it right?
Rob	Hands on activities.
Carl	Doing a lecture, lab, lecture, lab sorts of things, so that they are linked together.
Allan	The right people lecturing. That really makes such a difference. David was just gifted. That really makes such a difference. Roy was very good.
Researcher	Some of the characteristics other people have identified are, for example, the Kits. They thought the Kits were really important.
Carl	Oh, absolutely.
Researcher	So that the next generation, or next program should have a kit component, so that people will go away with something.
Kate	Absolutely.
Dorothy	Um-hum.

Kate	I think the handouts too have been really important. Just putting together a notebook, it's nice to have the lecture notes and so on, but all of the demos and things that are coming out. All the lab activities, you have a lab and if you've forgotten something and you look back it jogs your memory, it's right there. Um, those have been real useful during the year
Researcher	So is there anything else you want to add to that list before we finish?
Allan	No, I think we've covered a lot.
Carl	I would like this to continue. I hope the next program is as good as this one.
Dorothy	I agree, yeah.

Boston Focus Group

Researcher	Let me begin by asking about your feelings about the program, for example, in terms of difficulty, pace, appropriateness, or anything like that you want to discuss.
Bill	Exhausting. (chuckle)
Al	Yeah, overloaded at this point. I participated the first year and this year, not the intermediate. I liked the schedule of the first year better. I like the coordinated lunch time, rather than the break which we're on now.
Researcher	How is the organization different?
Al	By the schedule. The schedule typically had a morning lecture and in most cases followed by an associated lab to emphasize.
Bill	That was the first year.
Al	Then a lunch break and it's changed this year.
Bill	We did the two lectures then there would be a lab that would take us late. So it would be whoa, whoa, it would be very late, really late. Sometimes it would be 1:00.

Cathy	It was rushed sometimes.
Bill	I mean we started early, we started at 7:30, so that was a long time.
Al	It seemed like they tried to do too much. That was just what I got out of it. It was a well thought out program, I just think they tried to do too much.
Bill	Part of the difficulty seemed to be the amount of cognitive energy that would have to be expended because the topics are not simple and um, it takes time to accumulate the information. As it is after a Friday I felt like I was just following a schedule and not necessarily getting anything out of it.
Al	Um, I'm a cross-over teacher and I think that's the character of a number of participants in UPDATE, so there were many occasions in the laboratory that I ran into things I've never seen before. I don't find for myself sufficient time to really conceptualize what I've done, and I think a lesser volume of material with more time left to digest things, to discuss things, would have been, would have helped me more. I can see how some people at the other end of the spectrum might feel we're dragging our feet here. On the other hand, they have more opportunity to step in and teach it.
Bill	Not so much with the space physics.
Al	The labs pushed me a lot.
Cathy	Yeah, the labs. It was really something to get your graphs printed before you get to the next lab. Never mind lunch. (chuckle) Never mind trying to figure out what you actually did.
Al	Yeah, right.
Cathy	You're just trying to get that straight line but who knows what the straight line means.
Bill	It would be nice to have the time to consult with the other, you know, the other people in the program, not just the other participants but the staff too. We were running around trying to make things work.

David I know there was an attempt with some, who had mixed success, to formalize that discussion.

Al I think it was a lot of the timing, the end of the day, people were tired, long day, people want to go home, they're not really in the mood to discuss. We tend to do that on our own over lunch. 'What did you see ? What did you get ? Why did you do that ?' Possibly, recognizing that and leaving those time gaps in the format so that it will happened on its own.

Researcher How was the third week so far, here in Amherst? How do you feel about that?

Cathy Space here too, space again has been great. Probably because the speakers they have brought out have been fantastic.

David It seems like quantum mechanics is the top subject.

Bill But we need the time. I teach physics full time, so I'm teaching general and average students. So as a result, this material is something I'm not teaching, it doesn't have a common use. Even in the manipulation of basic calculus, it's tough. I'm not using it and when you don't use something, you need time to get back up to speed. Um, and there are certain aspects I was never up to speed to. So, uh, it takes time to get into the position to be able to handle it.

Al It seems, I guess there's a correlation with the first two weeks. The lectures on space were fantastic, I really enjoyed them and quantum mechanics, I don't know, maybe because space was so fantastic that I was afraid quantum mechanics couldn't live up to the same comparison. The same thing here, the space physics lectures were fantastic.

Al The lectures that we've had in space physics have been outstanding.

Bill Well, I personally feel we were blessed in Boston with the quality of presenters in space physics.

David I agree. And I think that, I guess for myself, when I 'm listening to topics and discussions in space physics I see things I can bring back to the classroom very easily. The things in quantum physics, I see for myself, hopefully helping me at some point, someday I might have some inkling as how to deal with it. I don't see that as material that I can transition it to the classroom. Um, at maybe some point in the future.

Bill	I'm starting to think about quantum mechanics and say OK., I 'm getting exposed, I'm getting, it's like I'm warming up. My hope is down the line, I'm warming up. My hope is now that I've got some of the vocabulary, some of the impressions, I'll be better able to understand the literature.
Al	The third time you read through it.
David	There's another physical practice that's lacking. I'm a visual learner and I would appreciate more visual simulations, more media incorporated. I don't know if such things exist, but I do know films in mathematics in the past like Flat World gave me a conceptual understanding. I would hope there is something else than what we experienced in Q.M. It would help, because the materials we got I haven't reached a point where I can understand them either.
Researcher	It sounds like you have seen the program change a bit since it first began. Can you talk about that? Either from year to year or from the first time it began to what it is now?
Cathy	It's more laid back. It's not so structured, not so stressful, not so jammed in.
Researcher	Do you think that's a function of the program or just getting sort of use to it?
Al	No I think the program has changed.
Bill	The subject matter was much more difficult this year than it was over the last two years.
Al	The first year was sensible. Like, where are you starting? And let's try this, and maybe that didn't work. And there was a real interplay of how the program was run on

a day to day basis and that's disappeared. That doesn't exist anymore. Now it's an imposed rigid structure.

David	I was getting the impression that it seemed to be an effort to coordinate all four campuses more heavily, at least in the first two weeks. Because the lab instruction sheets we got seemed to be, not generic to Boston, but they are using them on different campuses. Where the first two years, I got the impression, that each campus kind of went its own way with its own scripts. I'm not sure whether that an accurate portrait. It's an impression, that I, that I have.
Bill	I thought, in particular, the laboratory experiments. Some of the labs I have difficulty seeing how they can fit into what I do.
Researcher	All of you have been in UPDATE before, right? Either for a previous year or a previous three years, can you explain why you came back?
Al	I guess, basically it's nice to have work in the summer. It's nice to, I guess you could say, to work in your field. Um, it's nice to actually talk. For myself, I'm a fairly new teacher, it's nice to talk to other physics teachers and see how they do things. Um, sharpen up your skills a little bit and learn some new things. Um, the topics, very good topics in terms of space physics and the first year was astronomy, By June you're really burnt, I leave a program like this reinvigorated, it's going to help me in August in terms of reassembly and modifications of what I'm presenting this year. So, I see that as probably as greater impact, that's going to reenergize things.
Cathy	The first year, one of the things that really drew me back was the rigor with which the lectures were presented. That it was not such an elementary level like we teach all the time and actually had to put the brain into it and had to think about it. Mathematically it was very rigorous, especially for thermo. The first year I loved that. I loved that the first year. I was in my element. And I think the QED and the quantum mechanics has done that to a

certain extent this year. Unfortunately, that math is even so far beyond the thermo math that they can't even present it to us. So my niche has not been cut out for me, which is mathematics, so I'm not quite as happy this year, although I think that's just subject matter. I think, um, we get so isolated doing very simple presentations of the material, I need my brain to be exercised a little every now and then.

Dorothy

You know it's funny being a teacher. I always remember, I read an article, when I was in grad school, it was called, "The Lonely Physics Teacher". I find that true. I spend most of the day from seven in the morning to three in the afternoon basically by myself. Well, I have the students, but I don't have any other professionals to talk to or maybe listen to a lecture and try to stimulate yourself with something new. So this is kind of a nice outlet.

Bill

I'm primarily here for the intellectual stimulation. I'm tired after the year focusing on instructional techniques. I mean the conferences, the workshops I've gone to, they're always talking about techniques of communicating, not what we're communicating. And I need to focus on what we're doing not necessarily just the how. Um, and this is for me, it's not necessarily for my classes. I look for the bridges to my classes, but it's three weeks, uh, it's nice to be a student once in a while.

Cathy

Although, I think I forgot who was talking, but somebody observed during the last two weeks, I think it was Joe, it's much harder to be on this side of the desk. I mean when you're sitting and listening, than when you're up presenting, it's much harder.

Bill

It's different. We need that exercise. The key thing during the course of the school year, in my teaching career, being able to take a course in physics is almost impossible. They're offered during the school day. The evening courses are always on educational philosophy. (very elementary physics) But to be able to take something that approached contemporary physics, something since 1890 is rare.

Bill	It would help if U-Mass developed an alliance. The Lowell alliance is extremely effective.
Researcher	Let me ask you, do you think the program has affected your teaching?
David	I think it has given me some tools to work with. Especially seeing other teachers present their demonstrations. How they function in lab, you learn maybe little things about a lab you didn't know, didn't understand.
Bill	I find it hard to identify some simple things. I look back at my own education. I can't identify what I learned from a particular teacher, a particular year in school. In the same case, I know it that it has an effect. To specify what effect, I'm not sure I could.
Cathy	Mostly in questions kids would ask that I might not know the answer to. I feel more capable of fielding questions.
Al	I feel more confident.
Bill	Yeah, yeah.
David	I feel a great sense of confidence in dealing with a topic.
Al	The other thing is if I run into a question I can't answer I can refer that student or I can refer myself to other people, I've met in the program. I've been interfacing with people behind the program, at other universities. I feel more confident to ask for help from people. In the past I would have felt I was revealing my stupidity.
Researcher	So does that mean your curriculum has changed? Do think being in UPDATE has changed the amount of time you spend on these topics?
Cathy	I don't. I don't think I've really specifically changed anything.
Al	I'd say curriculum content, I still cover the same stuff but maybe the methods of getting the content across to the kids is presented differently.

Bill — Things change every year anyway. I'm sure I'm not teaching the same way I did two years ago or even last year. And next year will be different. These things become unconsciously part of it. I may have expanded those areas, areas I felt weak in before, but if you're looking for a major change I'm not sure it's there.

Researcher — What do you think are the most important things you've gained from the program?

Cathy — The contacts.

David — Yes, the people.

Bill — Not just uh, other participants, also the college professors, also knowing which ones you feel more comfortable with and which ones you don't. There are levels with dealing with a college professor as more of a human being and less of that isolated being in that ivory tower or that researcher that's in the lab all the time.

Researcher — You may not be aware of the goals of the program but the program directors have indicated there are five goals. I'd like to read you those goals and I'd like you to comment on whether or not the program has met its obligation to those goals. And any kind of comments you want to make about that are appreciated.

The first one is to provide participants contact with professional physicists and astronomers.

The second one is to promote networking, to reduce isolation among physics teachers.

The third is to provide an opportunity for participants to learn new physics.

The fourth is to provide an opportunity for participants to enhance their laboratory skills.

And the last is to provide new ideas for teaching physics.

David — I'd say most of them were met.

Al	The last one, the last one is probably the weakest. It happens. I think it's more typical of the other programs.
Bill	Essentially, yeah, I'd say they were meeting those five goals.
Cathy	Yeah.
Researcher	To a great degree, to a small degree?
David	To a great degree. Lab skills to a great degree.
Al	There was a time factor that affected the lab skills.
Cathy	Yeah, they set up all the labs for us. Everything was ready to run when you got there. Well, that's bad because we never learned how to hook up all of those coils.
Al	Or to set up the instruments?
Cathy	Yeah.
Al	To wire circuits from scratch, the skills themselves were great to learn.
Bill	It was a factor of time that impacted that more than anything else.
Cathy	Yeah.
Bill	A few labs might have worked. A lab that went two days is too long. Rather than trying to do two labs of the two disciplines, one of each every day, it might have been a good idea to reduce the number of labs.
David	It should have been one every other day. One day quantum then space physics the next day.
Researcher	How about the Academic Year Meetings?
Bill	Uh, yeah. I'm not convinced the academic years went very well. At least not in our area.
Researcher	How's that?

Bill	I don't know, it seemed like we were showing up for meetings and it, just to see what people were working on.
Al	Just isolated little.
Cathy	Same thing every time.
Bill	Yeah, same thing. My hope that next year will be driven with a specific presentation, uh, with a discussion following that. With the concentration on these projects and to be sure that they were done and to spend the time in those meetings to work on it, was a little bit destructive. I wasn't comfortable with it. Not that the projects aren't a good way, it was almost that the emphasis was on the grade rather than on what we were learning. The grade was being driven by the product not by the process.
Al	I believe on an ungraded situation where you're working on your interests. You know education is a very personal thing. As much as preparing for final exams probably does a lot of good for certain people because they focus all of a sudden, um to spread it out over an entire year, I don't think was productive. It may not be productive this year. I don't know how it's done on the other three campuses.
David	If the meetings are during the school year, we lose an opportunity for us to be exposed to additional facilities, events, you know that the university staff is aware of or can access for us because of our association. And at the same time, if it's compulsory for us to be working on these projects, we do need the assistance. Free access to the people who are grading the projects, but to use the projects, or that sort of work as a purpose for assembly, like we said it became a drag, particularly the first year people came 45 minutes late.
Bill	Part of it could have been blamed on how Martin conducted the meeting. Martin would spend four hours talking about points that could have been handled in three minutes. (chuckle) He did it to reach consensus. He wanted to make sure everyone was comfortable. Um, and it isn't necessary, so people started to come later and later and

late. (chuckle) Um, it was less overt last year. Um, he learned a lot.

Cathy He learned a lot. He has improved.

Bill He has understood some things about coordination. He's learned politics, he's learned all sorts of things. I'd say that some of the staff has learned from experience too.

Researcher Do you think your participation in this program has affected your physics students in any way?

Al I couldn't verify that directly at this point.

Bill I'm involved in some other programs too, so I couldn't guess. I've had students who have struggled through college programs, that were more technical than they were in the past and I think I have a better conception of what's available. But there are other programs, I'm involved in M.I.T. as well.

Researcher Well, I'm thinking of more of the trickle down idea. Does your participation here, what you've gotten out of it, you've mentioned new ideas, more enthusiasm and so forth, so in that sense do you think your students feel that effect?

David I think one thing that has happened is the rebuilding of my misconception, in terms of U-Mass. I'll be honest with that and I know I convey that to my students.

Researcher UMass in general?

Al The Boston campus.

Bill I consider it a real jewel.

Al Unknowingly, I was probably basing my misconception of UMass on my perception of ten years before that. Come to find out the U-Mass campus downtown is totally rebuilt. I know a couple of students who have taken advanced programs and things of that nature.

Bill I developed a perception of all three, all four campuses because I've started to uh, to attend meetings of the alliances of Dartmouth. And the week we spend here, we see what's available here, what type of research is being done. It's definitely had an effect. The other side of it, as I've said it helps in confidence. After the first year, I got nominated for the award, uh, over the last ten years, the presidential award. I never thought of it. I thought of it after the year I took the UPDATE program and I can't help but think it has to do with the fact I'm more comfortable with this. That was kind of a success for me professionally and I can't say I give total credit to UPDATE, but I can certainly say that it had an effect.

Researcher	So it contributes?
Bill	Yes, it contributed to my professional development and it continues to do so.
Researcher	Was there anything in the program that you expected or something that you wanted to receive but didn't ?
Al	(laughter) To say we wish we had done this or that changes the intent of the course.
David	I just go back myself. I wish, I found myself a lot of times I just didn't finish a lot of the stuff in the labs. Um, there's so much to do. Yeah, I probably could have stayed till seven o'clock at night and finished things up.
Bill	It would have felt nice to have finished things.
Al	Yeah, I just felt like I was, you know, you reach a point in the day, you get a little overloaded and you need to go home and just kind of tune yourself into something else, so I think that maybe, I just felt, it was just overloaded. Things, let's say we could have taken a little bit more from, say, one of the topic areas and maybe it could have been planned a little better, I guess.
David	I feel like I hadn't put as much in as I should, and it was somewhat a factor of exhaustion, with everything from the year as well as the day.

Al	It was just I mean the way things were rolling. I mean some days, like I ran into a couple of lab setups, things went crazy. It took us like an hour and fifteen minutes to figure it out.
Bill	You stayed real late one night.
Al	Yeah. It's just that, you know, to finish things up because maybe things go wrong in the experiment and uh, especially if it was in the morning, the wait time, and I couldn't go back.
Bill	I found one thing I found a little difficult for me relative to this year's labs is that it depended upon computer analysis. Uh, what about us who don't have access to that kind of equipment? The transition of that information, you suddenly begin to think, now how can I modify this so it's paper and pencil and it comes out the right way. You know, I realize that is ultimately where you want to go but a lot of us aren't there.
David	Probably a presentation on something like the calculators, I think graphing calculators would have helped. Instead of using computers and stuff.
Al	There could be some tool developments, which would be more appropriate to what we have available. If you used the same equipment we had available, it would make more sense.
David	These guys have to assume our facilities are pretty minimal.
Bill	But it was nice to be able to use some nice equipment.
Al	A lot of things I sat down to I needed more time with, maybe that's something I hoped for a little bit more. Now, on the other hand, let's say Nareesh is spectacular, particularly in lab when you're having problems with things. He's very patient and he's very good, but sometimes as you said you get to the point where you need to go through things several times, you know. Now this is the third time asking Nareesh the same question, and you say you begin to feel like your students.

Bill	I do have a wish list, although the stuff we were given was really good, my wish list is that every participant would have been given a computer with a modem, with the software to take back to their schools, and an e-mail account or an electronic connection so that the communication could continue, not just for a year but for a longer time. And um, I realize I'm fighting that tide about money but we invest in a lot of things, and that wouldn't bring that type of long term communications. Not everyone in the group would never, we never educate every kid in our class but what it would do for a sizable number of people to give them a piece of quality equipment and give them the opportunity to use it effectively in their teaching would have produced an electronic community, and a steady community, that would survive the funding of this program.
Al	To be able to go on with ease to our individual Resource site or a broader Resource Center, in terms of looking through recent additions, finding information that's there, posing inquiries, I mean I'm dealing with this today and go back in the next day with something that gives us responses from the people or that you've met this week or spend time that would be uh, that would have a big impact.
Researcher	Were there any unexpected outcomes, or surprises, that you got during these past three years at UPDATE?
Cathy	Yeah, I never expected space science to be as wonderful. It just was fantastic.
Al	Yes and their willingness. At some point that becomes very accessible. I didn't expect that. Between the staff at the other Universities and certainly at Boston, certainly at all the different schools. The uh, their accessibility. I mean everyone's leaving their information in terms of if you need to contact me and if you have questions about these things and if you want to bring your kids in.
Bill	There are some marvelous resources. That physiology book is an incredible resource. I really don't know what the other three campuses have done.

David	There was something, the first year Lowell got very high marks because they had grad students helping set up the labs. First time Boston had that this year. Now it assisted in some sense, because we were able to do more sophisticated labs but the down side we didn't do the setup, and that's what we need. Yeah, there's obviously been an attempt at Boston to take what had been mentioned from the other campuses. I saw that going on during the entire project. That there was an effort in everyone's case to try to improve the delivery. That they learned from the success at other campuses.
Researcher	There's only one more question that I have for you people and that is, should subsequent programs be developed, can you think about some of the characteristics of this program, that were so successful that should be continued?
Bill	I like the research labs. I like the visitations and the field experiences. There's a little bit less of that this year.
Researcher	What do you mean by field experiences?
Al	You mean field trips to different places ?
Bill	To different places. I actually talked to scientists and engineers that are working on the day to day problems of finding out the answers to the questions being posed, um I like to see how science is done in the real sense. Not just what we get in, you know our textbooks are very antiseptic, if I could bring back to my student that feeling. I need to renew my feeling to the way science is done. I don't get it by staying in my classroom. Um, it's an area I think is important. In the past, I would have been afraid of that. I thought of researchers as being really out to lunch, uh, nothing is farther from the truth. Um, I would crave that and look forward to be able to share that with my students, either directly by taking them to similar experiences, or uh in a secondary fashion, by telling them what I experienced.
Researcher	How about other parts of the program that you thought would be strengths and might be appropriate elsewhere?

David	I thought it was, I really liked the lab activities. I thought that another program should not get rid of any of the lab activities. As much as I complained about not having enough time, I really enjoyed myself. Maybe it's just I'm a slower worker, but um I really thought those were the highlight of the day.
Cathy	Also to keep it at the same intellectual level. Not to dumb it down at all.
Researcher	You mean a high intellectual level?
Cathy	Yes.
Al	But to be able to deal with the fact that occasionally each of us will need a break. So that there is the time or there is the capability of when it's, it's, so somehow we can fill each other in and catch up. Otherwise what happens is that you lose someone the first week and they'll never catch up. I thought there were a lot of components of this program that allowed me to catch up on things I didn't understand.
Researcher	Um, like what ?
Al	Well, the discussions, the questions. I wish I had more time but um, it was the capability of experiencing some of the ideas in the lab. I'm not convinced the labs matched the material all of the time. Um, I don't think they had the time, the planning time to design this program. By the third year they were still trying to clean up some of the things that had happened in the previous two and all of a sudden that had come up with a whole new program. I have an impression, they built upon things they were all ready doing. Rather than developing some new things from scratch, that really addressed the goals of this program. Uh, quite often the labs we were doing, were the labs they were doing on college campuses and we just remade them to figure out how they would fit into the program, whereas it would have been nice to coordinate them more closely with the lectures and the presentations. But that's something that takes more time than just three nights in the spring.

David	You mentioned about the lecture level, I found on an occasion that I too. At a lecture that I didn't understand, I'd ask Steve. He's more than welcome to sit down and clarify. The labs enhance that because of small group settings. You have two, three person teams, maybe a few teams, unlike how the lecture was done and maybe somehow and taking the lecture format and breaking that into smaller groups, um to let people digest it. "Was this clear, do you have questions about that?"
Cathy	Yeah, question and answer period in small groups.
David	That was great, but it didn't happen this year at all. It was very easy to be a kid and be in back of the lecture hall and not mark your time. It wasn't like that the first year at all. It was much more intimate in terms of the interaction.
Bill	I didn't like the layout of the room, where our lectures were. I thought it was destructive.
Al	Not like Boston.
Cathy	It was also 60 degrees in there everyday.
Bill	What was it three years ago it was close to a hundred a couple of times.
Cathy	I don't remember that. I just remember being cold everyday this year.
Al	That's one area, the environmental conditions. I did not look forward to coming here this week. You see more and more people spreading out so you aren't getting body heat from each side. It was my big concern about the second year is to have everyone come instead of just a few because it really filled up that lecture hall and made it difficult. It was tough to stay awake because it was too warm. Physiologically it was a real mess. There was one I liked and that was last night when we went out impromptu to see "Apollo 13."
Cathy	I had seen it before hand. I had seen it maybe a week, a week and a half into the

program and I had to kill myself through the whole movie not to lean over and tell my husband, "Oh, but they said this in class and this is how this is related to that." It was just perfect timing. Twenty of us went, it was just fantastic.

Al — I don't know whether a program can mesh with the media so well. (laughter) Um, it would have been nice to have that same environment for each of the topics. I don't know if there is something that's entertaining in quantum, (laughter) but I'd like to find it.

Researcher — Are there any other issues you would like to discuss?

Cathy — I don't think so.

Bill — All set.

Dartmouth Focus Group

Researcher — Let me begin by asking about your feelings about the program, for example, in terms of level of difficulty, pace, appropriateness, or anything like that you want to discuss.

Amos — We were very pleased with the program. I've been pleased with the program on the local campus all of the years and the professors are really student orientated. They have to focus on the student, not always true at some other large research campuses. They did a good job in both guiding the theoretical lecture part and in the presenting the nice experiment program, and that was true all of the years, not just this year.

Brenda — To add to what Amos said, um, I also feel that our instructors were excellent models of teaching style, in the way they dealt with the students, the way they changed their pacing to meet the needs of us and the students, it was all excellent.

Carla — I thought they were all extremely well prepared, you know all their notes were ready and if they had any demos they were ready, they just had everything ready on time. I'm really happy they dealt with us as individuals.

Researcher	How about the labs or the pace or anything else you want to add about the first two weeks?
Don	No just again that they paid attention to us and there seemed to be use to being with a wide range of students, and they all had their act together, their notes were neat and ready, and the labs were understandable. Everything was in place, just like you would have with an ideal high school teacher I think, and not a recessive teacher type which I've been exposed to, been exposed to many times.
Don	And so, I think they're excellent models for teachers, good models for high school teachers, because you have to be organized like that.
Amos	I like the labs because you got to do lots of things which you probably would not likely do in a high school setting because of basically the expense of the equipment, also a lot of the labs, when you were all done you could pack the stuff and take it home and now have this new little toy thing to do with your kids back at school. Just being able to have that bag of things, not oh well there's something else that if I bought it or made it I'd have it, no you had it when you left.
Researcher	So you think the kit component of this program was important?
Carla	I used my stuff a lot, even I didn't always plan exactly how I would use the stuff, but all of the sudden I would say I do have that stuff and I knew how to use it too. It wasn't a matter of having to say oh wait a minute I'm going to have to go out and buy that myself, which I know would come out of my pocket so that would be an added incentive not to acquire it and then play with it in time to figure it out, but I knew already and I'd be able to set something up and have it ready to demonstrate the next day and that was wonderful. I know I will do that with the material from this year as well. The same sort of thing, I'm already

rehearsed somewhat or familiar enough that I can utilize it much better then having got papers or just a demo in front of the room and then I have to put it together.

Researcher How about the third week, how have you found the third week at Amherst?

Amos I didn't find the third week as good as the first two weeks. Always at least one of the two lectures wasn't good and, uh, there's also a tendency to present certain aspects of the topic which aren't as useful to us. I mean there will always be some very specialized aspect of the topic that the guy got into, even the coherent one, there's always one that isn't, every year. Didn't seem as useful to me as the stuff at the home campus, which was always directly related to what we need.

Researcher Do all of you agree or disagree with that ?

All Yeah.

Amos All with the exception with the astronaut presentation, I thought that was pretty good.

Brenda You could easily tell it was canned. But it gave it the flavor of being in the theater. I'm not sure if he was trying to give that effect, he could have easily done it in a conversational type voice if he was trying to create an environment for his presentation.

Carla I saw him do the almost the exact same presentation at the National Science Teacher's Convention in Philadelphia, so when I saw his name I knew he was going to do that type of thing. When I saw him the first time it was a little bit shocking for the first few minutes and then I kind of enjoyed it, I took it for what it was, almost like a little theatrical production, but it was very interesting to see the human aspects of astronauts. I've heard probably eight to ten astronauts speak, I always run to hear them whenever I can and that was the first time that somebody came across with something other than the 'Right Stuff' and I thought that was very interesting. Um, I teach astronomy and my kids just love to do space travel for the whole year, you know that type of thing and they always love any little tidbits you can tell them about the astronauts, so even something as simple as him saying he takes six tapes up into the shuttle with him would be very interesting to my kids, because this is the kind of stuff that they want to know.

Researcher — How do you think the program has changed since you were first in it ?

Amos — I've only been in it the two years, the last two years, and it seems very much the same with the exception of topics of course. The approach and the way they do it seem quite similar.

Don — Seems to be quite similar year after year.

Brenda — It was my first year last year. The first year I didn't come up here.

Researcher — The first year there was a distinction now between the experienced and inexperienced teachers, do you think eliminating that distinction was a change for the better or a change for the worst?

Brenda — We felt, the people who stayed behind the first year felt kind of neglected and something like second class citizens for a little while, but then enjoyed our third week up there. I think the third week was extremely beneficial to us because we got more of what we wanted, and spent a lot more time interacting, so after we dealt with being sent up there we had a good time.

Researcher — All of you have been here for more than a year and some of you for three years, what made you to decide to repeat or come back ?

Don — For one reason and it was great and it was fun.

Carla — I like interacting with all the high school physics teachers, I got a lot of ideas from them. Even exchanging war stories was good, you finally realize you're not alone. Also certification.

Researcher — The P.D.Ps for recertification in physics?

Carla	Yes.
Amos	Another goodie bag, toys.
Don	Yeah. Absolutely.
Brenda	I don't know what's most important to me. The enrichment probably primary but second is the interaction with other physics teachers. I always say teaching physics is a lonely job. You very seldom get to play ideas off of other people and just the sense of humor someone with physics training has, is a little unusual too (chuckle). I mean interacting at that level as well. That's wonderful, making connections because you network with teachers from all around and there really is a bonding, that's wonderful. And with the instructors as well, very much so.
Researcher	Do you think the program overall has effected your teaching?
Carla	For me definitely.
Brenda	Definitely.
Researcher	How so ?
Don	Maybe more sophisticated, I think you just have more knowledge.
Carla	It reinforced my belief that hands on is extremely important because there's a lot of pressure to do the traditional you know equations and do calculations and that's it. And time in schools and budgets now keep putting pressure on doing less experimentally and it made me personally stronger to say no, we have to have the money or I have to go through the struggle to have the kids do more hands on.
Amos	To some degree I find it re-energizing. I certainly wouldn't come back here the second time if it was a continuation of what I had done all year long with my kids in school, uh, it's completely different. I went up to a vacation place with my brother and sister and they had their sons and daughters, so they're my nieces and nephews and they ask what I've been doing and I say I've been in school and it freaks them right out. (ha,

	ha) Yea, and I'm doing it because I want to. (Ha, ha)
Carla	Oh the kids before you leave school, you know so what are you going to do this summer. 'Well, I'm going to school for three weeks.' 'What do you mean you're going to summer school, are you nuts?'
Brenda	I can't believe as you said you choose to do this. But it's fun to be a student. Isn't it? It really is. It gives us a different chance to appreciate the learning process, from a different point of view.
Carla	Also, it makes you think, you know you wonder what you're like in front of the classroom, when you see some of these people, like I would never. (chuckle)
Amos	You get lots of experience saying that? (Chuckle)
Carla	The other thing I found the first couple of years I taught astronomy, people would say it's not a lab science, it's not a lab science and I think after the first time I came to UPDATE, I said, 'its going to be a lab science' and the labs I've incorporated in the last couple of years have been truly amazing. Just from ideas that I got and all the toys that I got, um, very, very weak on electronics and the first time we had to do something with the board. I'm still not very good at it, but at least I know what it is.
Researcher	So do you think that your curriculum has changed because of your participation here ? Are you adding things, spending more time on certain topics?
Amos	Not more time, but I might use one or two of things that had been within the scope of what I was already doing.
Researcher	Do you largely have the freedom to design your own course?
Don	Yes.
Brenda	Um, Yeah.

Amos	Is this going back to my curriculum supervisor? (chuckle) I have a curriculum supposedly, but I never look at it. We can do whatever we want, whenever we want, the way we want, it's really a nice thing.
Don	I understand that it's not like that in some places.
Amos	I think in the Mid-West or something, they have a centralized system, I'm told, I don't know.
Researcher	So you haven't made any wholesale changes, for example, thermo-dynamics is really important so I'm going to add a whole section, nothing like that?
Amos	Well, just small additions to what I already do.
Don	Not really big changes.
Carla	I didn't add units but I added a demo here and there and I do a little more with electricity.
Researcher	What do you think the most important things you've gained from the program are, let's say overall, all the years you've been here.
Amos	I think the experimental part is really important. All the demonstrations when we go to campuses, we have the labs that are presented in the first two weeks. So there's a lot of experimental physics you can catch if you pay attention.
Brenda	Inspiration. In general that would encompass it and to see really good stuff going on with a lot of other people, really neat ideas.
Researcher	Other physics teachers?
Brenda	Yeah. Crazy demos, people enjoying what their doing and proud of what they're doing.
Carla	Also a little bit of humility. It's an incentive to say yeah I need to go out and check this stuff out some more and make myself a little more knowledgeable.

Amos	This is kind of unfair to say what was the most important. I like our experience with John Russell, he pretty much opened the door at U-Mass in terms of he'd be willing to lend you stuff to use in class that you might not have access to, and not apparent to me, willing hold back anything. Hey, if we have it and we're not using it, you're certainly welcome and free to take it. That is really foreign to me. Just to have that available, I used it several times last year and probably will this year.
Researcher	Have the rest of you taken advantage of resources?
Don	Not as much, but I will.
Researcher	How about in terms of human resources, like asking questions of the professors if you're having a problem with something or other?
Brenda	I have at the alliance meetings and even during this time. Yeah, definitely. I feel as though they accept us as peers, they're wonderful, really wonderful.
Don	Considering knowledge wise, we really are not peers, they are wonderful.
Brenda	Yeah, yeah they're so down to earth and kind and generous.
Don	Absolutely.
Carla	I haven't called them for anything but I'd feel very comfortable doing so if the occasion arose where I felt as though I wanted something or other. Definitely.
Researcher	You may not be aware of the goals of the program but the program directors have indicated there are five goals. I'd like to read you those goals and I'd like you to comment on whether or not the program has met its' obligation to those goals. And any kind of comments you want to make about that are appreciated. The first one is to provide participants contact with professional physicists and astronomers.

The second is to promote networking, to reduce isolation among physics teachers.

The third is to provide an opportunity for participants to learn new physics.

The fourth is to provide an opportunity for participants to enhance laboratory skills.

And, the fifth and last is to provide new ideas for teaching physics.

Brenda	Are you into archery at all?
Researcher	Yeah?
Brenda	I just see five bulls eyes.
Carla	Absolutely. Wonderful.
Don	Wonderful metaphor. (laughter)
Amos	Yeah, I think they have met all of their goals. Perfectly. Also, I like the way the goals are stated. So often you find goals written in such a way that you wonder what they are saying.
Carla	Which brings me to something I want to say just in case you don't ask it.
Researcher	OK
Carla	This program is refreshingly free of psychology.
All	Laughter
Carla	This is what's wonderful about this program, it's all physics. It's not all that Ed. stuff. It's not about psychology.
Researcher	Well, that's important to say. It's important to know what to exclude in programs as well as include.
Carla	Absolutely.
Researcher	Do you think your participation in UPDATE has had any affect on your physics students?
Don	I'd like to think so.
Amos	Yeah.

Don	I don't know how I'd prove it but I'd like to think so.
Researcher	In what way do you think?
Carla	I'm a more sophisticated physics teacher now.
Amos	I agree with that.
Brenda	I think we have more enthusiasm now, and that shows in the classroom, and that's very obvious to the kids. They'll say so many times, "Gee, you really seem to like what you're doing". or "Boy, you like this subject don't you?"
Amos	I think the kids are more impressed with you when you are better informed and have more things to do. It's a lot easier to teach. It makes your job a lot easier, you have less discipline problems. Like, I love it when the kids jump when the bell rings, "Oh my God this class went by so fast".
Brenda	To me that's such a compliment.
Carla	It is.
Don	Yeah.
Carla	They will tell you after that, that it's fastest class of the day.
Don	I like the connection with the real world. We went up to Northfield, the power plant. Uh, Millitech, uh, but just seeing science in the classroom is not science. This is science that really happens. People do things with this. I try as often as I can in class to connect anything we are doing with something that happens in the real world.
Researcher	Is there anything in general that you feel the program did not deliver on?
Carla	I think in most years, the speakers here didn't follow up. They would bring in someone for the third week and there was no connection to the first two weeks.
Amos	I just wish there was more time. I don't really want to give up more weeks in the

summer but I kind of feel as though we are on a roll and there is so much more to know. I would have loved a segment on particle physics. I feel as though we really didn't fully tap the resources of our instructors. I feel like, wow, give me more.

Don	Are you going to ask questions about the winter part?
Researcher	You are welcome to comment on that.
Don	I found the winter part difficult to do during the school year.
Amos	Yes.
Researcher	In what way ?
Don	Time. Time-wise. Most other teachers I talked to felt the same. So, I'm wondering if maybe that component maybe shouldn't be done at the end of the summer, or something like that.
Researcher	How about what you were asked to do during that time? Did you find it useful?
Don	Well, I found it hard to do properly. It bothered me.
Carla	I thought it was nice to get together with people and find out what they were doing for the past month or so.
Amos	Yeah, yeah.
Carla	And, you know, just bounce off of each other. In terms of being focused on a project, that was difficult. Whose doing what and how are you doing it, but you come back in a month and you haven't done anything towards the goal. We did a lot of ours after we got back into this the second year.
Researcher	If you had a chance to change that, how would you do it?
Carla	Not do it. Either not do it or do it at the end of the summer. I mean, people don't realize that during the academic year, high school teachers are under tremendous time pressure.

Don	There is a lot of pressure, so much, so much.
Researcher	Have there been any surprises in terms of what you have gotten out of the program that you didn't expect?
Don	A lot more electronics. All three years they stressed learning about things through electronics. We built a lot of circuits. In every topics there was electronics. I think that was great.
Brenda	I think that too, but I don't have that third year, so I thought it was just the nature of the topics that we covered. But it did kind of surprise me, how much electronics we did.
Amos	I was very deficient in electronics. I would have enjoyed a tutorial type thing on it. I didn't want to ask anyone to give up their time, but that would always be the type of thing that we could do during the yearly meetings instead of these little projects that we have. We could work in small groups and maybe learn something about stuff that we weren't to good at.
Carla	I thought the computer part was a bonus. I never expected when I started. We spent time with data collection and on the net. Where good places to go on the net for physics resources.
Brenda	They did that at Boston. They did analysis with every single experiment that they did.
Amos	I always think that we should do more enrichment for us. Inservice kinds of things. The computers would be a good thing for the Saturdays that we get together. Instead of the projects.
Researcher	Think about the highlights of the program, the characteristics of the program overall that you think should be characteristics of the next or future program. Can you identify some of those?
Carl	Emphasis on physics, physics, physics.
Amos	Uh huh.

Don — The interaction of students and teachers are important. Not only do you get to meet different people and make different contacts, but also to scramble the groups like we did this year. You were feeding off of other people's strengths. Teamwork, one of those astronaut words. Everybody, at one time or another, got to be sort of a leader because they knew what was going on. One thing I didn't like was getting those labs thrown at me cold. We spent a lot of time just trying to figure out what was going on. It just re-emphasized to me the importance of my, my kids, when I tell them that lab preparation is very important time. We don't have the time to afford, fiddling around with how to do this lab. Know it when you get here. I tried to coax them into giving us those labs ahead of time. They were a little reluctant to, I don't know why. Did you find that also?

Brenda — Yeah. I sort of had that feeling that several of the labs we cartwheel our way through. When we were done we would wonder what we did. What was the explanation? I think a lot of that resulted from people being at different levels of expertise within the lab teams.

Researcher — How about the format of the program? Do you think that should be carried over to another program?

Brenda — Yes, but I think the way they did the labs, some of them were supporting what you knew and some were discovery. Our labs, this year, seem to run out of sequence with what was happening in the class. Last year I felt as though the labs matched the lectures more closely.

Don — I think the third week should be a little more teaching oriented somehow. More people oriented people.

Amos — I also like the way we were one day on a topic. Whereas here, I have difficulty changing gears.

Researcher — There has been kind of a debate about this program. Some people have said that this program is basically for teacher enhancement, which is to learn new physics and so forth, and then there are those people who say that this program should really be a time to learn new teaching ideas. How do you feel about that?

Carla — I think you can have both of them. I think we have done both.

Amos — Yeah.

Brenda — We are mostly veteran teachers, right? Last year I remember there being a few more young people new to teaching, but the majority have some years experience. So, to me, enhancement is what we what, and we share a lot ideas and we get that as a by-product of the program. We do that on our own with the demo sessions every morning and the gabbing we do the rest of the time.

Researcher — Is there anything else you would like to say before we close?

Amos — One of the things that I was impressed with was that all of the professors were there all of the time. I thought because we had different topics each day might be that the professors would come in every other day. But they always popped in and out. Even when we were doing labs, the space person would be there to see what was going on in the quantum lab. They were very much concerned with pulling it all together. I was kind of impressed that they would be there all day long.

Don — Our teachers were great students also. It was very inspirational and last year I remember that during the third week one our guys was always asking questions and this person must be sixty or sixty five years old and has the enthusiasm of a seventeen year old.

Brenda — We had a lot of other people from the physics department who were in our physics labs who were interacting with us. They are very enthusiastic learners.

Carla — Physics groupies. (laughter)

Lowell Focus Group

Researcher	Let me ask you about the first two weeks of the program at your home campus. How did you find that this year?
Brendan	This year I thought it was very well organized as my third year in the program. Everything was kept right on time, uh, the lectures though sometimes time were a problem, uh, we were able to get through the material. Uh, the labs were pretty well structured, so by the third year I think things were all worked out.
Daniel	I think they tried to address the concerns we had of the previous year. I think they did a very good job of that. I was only in last year, not the first year but probably last year to this year they tried to address the problems that we felt as teachers, as participants the problems.
Researcher	What are some of those things?
Allison	Time considerations, the amount of time.
Daniel	Yeah. They were really good at that. Particularly if they knew that a lecture or something was going to run late, it seemed like the lab we were going to have during the next block was a shorter lab, so that we weren't always in a state of rushing, we could actually take some time to do it and talk with each other and not just trying to get the data down or try to get to lunch or something.
Corrine	Yeah. It's hard to be intensely involved in something from 8:30 in the morning to 4:30 in the afternoon and have that same, uh, high peak of interest, and being able to pay attention. And the first year, one thing they tried very hard to do was pack it with lot of things for us to learn and a lot of things for us to do. And through the years they modified their approach so that we could handle it. So that we weren't overtired, overstimulated, but they had that positive intent of trying to give us the maximum and you can't, you can't from 8:30 to 4:30 straight and then back up time, so lose lunch because you've got to make up time and don't have a break. They had all

that good intention but they just got a little carried away. And that, um, is an amazing thing to say about a program, that it was so good that they had to like scale back a little bit to give us down time.

Brendan — But you never felt like you were given freedom before.

Corrine — No.

Brendan — Yeah, or to work continuously or continue on a particular lab or something, or to ask questions after class. You get there now and that's it.

Daniel — They're also really open, whether it be like uh Dave and Art or ... you could, you could if you had a question, you could ask them and they'd try to help out or try to explain it, whether it'd be during the time block or after time. They were real good about that.

Researcher — How about the level of instruction, do you think it was appropriate for high school teachers?

Allison — I think that they were perhaps thinking the teachers would be coming in with a little less knowledge than the group that I think we have, happens to have.

Researcher — So, they were shooting a little low?

Allison — I think they did. I don't think that was necessarily the wrong idea, but I just think that maybe in my experience when I was an assistant in a lab, and NSF lab situation, years ago the physics teachers there were literally incompetent as far the level of knowledge they had, compared to the group that I think they have in this group.

Brendan — For someone teaching twenty plus years, I'm sure some of this stuff was repetitive, but I'm new to the physics field so I learned a lot, and uh, so I took it from that end. So we had a wide spectrum here. I can see a twenty-five year veteran coming in and saying I know some of this stuff. But some of the lectures probably went way over some peoples' heads, some other lectures, people said "Oh I understand what's going on".

Corrine	Right, with a varied background of twenty-four people. Like I'm strong in chemistry, but a lot of people spent number of years in teaching physics and maybe went to other institutes. I think if maybe I was the teacher that had to come in and set up the lectures, it would be very difficult to decide how to make it so it wouldn't be too hard or too easy.
Researcher	Well, you know the first year there were two different levels. Do you remember that? It was divided into experienced and inexperienced teachers. Do you think that's a good idea or not a good idea?
Allison	I'm glad they did away with it, because I didn't get to come out here the first year and that third week, the first year was a waste of time. Really didn't get anything out of it and we made a strong recommendation to include everybody out here for the third week and I really enjoyed myself last year, and I was glad I was able to come out here again this year.
Corrine	Well, I didn't know where to put myself. I'm like intermediate and I was worried if I said I was qualified to come out for the third week that I would be in over my head. Yet if I put in to stay that I would be bored and I was very glad that I came out to Amherst for the third week. I didn't have a problem with it at all. In fact, I think it's easier the third week that we come out, then it is the, uh, the two weeks at our own campuses.
Researcher	Speaking of the third week, how are you finding this week here in Amherst ?
Daniel	It varies. There is a tremendous variation. I mean overall, it's a lot more of a relaxed feeling than it was last year. Last year, again, you felt like you did this and then you'd go into that and then right into that. It got to Thursday night last year and I was ready to find the most mindless thing I could possibly do, because I felt like that was the first time that I actually had some time.
Corrine	I like the tours.

Allison	Yeah, we did the field trips last year, which were a very long days. I mean last year was very regimented, we were on a tight schedule and uh, the weather was nine thousand degrees inside. Everybody was just kind of dragging, not everybody, but Friday, uh couldn't get here soon enough. But this year is more relaxed, more free time. Obviously they couldn't have built in any field trips depending on the topics, but people seem to be a little more relaxed this year.
Corrine	I like the field trips. I like going to the, uh, where did we go last year for the communications?
Daniel	The radio station, WFCR.
Corrine	I thought that I'd never be able to get into a place like that and just look around and observe inside. Just watching the people working, looking at all the equipment. That's what the students will be doing in the real world. It just gives me a different perspective as to where I will be sending them, if they should be going in that direction. I like that kind of field trip. I also like the, um, when we went to see the radio telescope. Didn't we do that one year? I like that a lot.
Allison	First year was the radio telescope, I think.
Corrine	OK.
Allison	Yeah, at UMass.
Corrine	Right, the first year, and I like that trip too. Um, all of that is just a great background for the classroom. I brought a lot of that stuff back into the classroom. It was really of interest to the kids. It was something people really do. That was a tremendous help, I thought.
Brendan	I find the demonstrations to be very good. Particularly last year the hour we had with Karl.
Daniel	Yeah, the morning demonstrations were very good, but the hour and a half session we had with Karl was great.

Brendan — Last year's were very good, this year's were also good. I think it was more difficult to give us demonstrations for the topic this year.

Researcher — What do you think about the topics this year?

Daniel — Like what Brendan was saying, I think a lot of it, I think a lot of the experiences that come out of this thing can go right back into your classes. It's not that we are going to bring quantum and bring it wholeheartedly into the classroom, but when you're going through things, there are now things you can draw in, and you know, like with space, here's how this is used there and here are examples. Because a lot of the kids just go, "well why do I need to learn this, or where is this used, or why?"

Brendan — I think that's the difference between the two topics this year. The space topic out here is a continuation, is a follow-up to what we did at Lowell for the two weeks, which was like a preparation and the quantum up here. It was almost a repeat of what we did instead of a follow-up, if you know what I mean.

Allison — That's been the general feedback. The space topic, that's why I decided to come back this year. It's fascinating. I could have listened to Mike Mullane all week and then I'm looking forward to Janice Voss. Um, I've always been fascinated by that kind of stuff. Quantum, yeah, it's uh an interesting topic, but it's hard to make it appealing.

Researcher — How do you think the program has changed from its beginning? Some of you people have been here for three years.

Brendan — You've been here three years?

Corrine — Yeah, I've been three. Um, well I don't know if I can look at it in terms of change, I can look at it in terms of structure. First, in the structure, I think, uh, it was a nice setup to have a lecture, a lab and then break, then a lecture, and a lab. I really like that they've committed to having so many labs for us. Tremendous variation and that's been very, very helpful to me. Um, the lectures I liked also. The people at Lowell have worked very hard at putting their booklets together for us. I couldn't have, uh, if I had to do that for on my high school level, come up with something, there would be days that it might be good and there would be days when I'd be putting the kids to sleep. But there were volumes of information for us to take what we could and they stayed steady with that for the three years, and they worked really hard at it. I know how hard it is to put together a lab and how hard it is to do it for twenty-four people, so, um, I commend them on that.

Allison — Yeah. We as teachers appreciate that and we complemented our staff at Lowell. Um, it was very hard, and I've always seen great time dedication to it. Some of the labs, we had difficulty completing in the two hour time block, um, some of them we were able to get done. It's hard and, uh, it works overall. The lecturers this year were pretty self explanatory, they include bibliographies and stuff, where this stuff is coming from, so no real complaints there.

Researcher — Everyone here has been to UPDATE more than one year, and some three years. Can you tell me why you came back for a second or third year?

Brendan — Personally, I get a lot out of the labs. As I was just saying. I don't think I get quite as much out of many of the lectures, but you also get a lot out of talking with the other people, you get a couple of labs that aren't even presented, you get demonstrations, watching other people do demonstrations, you get ideas from those. And, uh, I won't hesitate to say that this is the first time in I don't know how many years that I've gone back for credits and actually been reimbursed for them. And, uh, I gladly gave up three weeks of the summer for this.

Allison — There were financial considerations. I'm going to be straightforward. Yes, of course the financial rewards were too good to pass up. I was looking to, uh, advance my physics background, um, the money was there, why not. I did it for two years and I was on the fence of coming back this year, but I said what the heck. Who knows when an opportunity like this, is going to come again. As it turns out, I'm going to get eighteen credits in physics for probably one third of the price, so, um, those benefits are good. So who knows when something like this will come down the Pike again, so I grabbed it.

Brendan — Especially, with Ed-Reform.

Corrine — Yeah, very pragmatically, I have a little one and he had to be in camp for a month in order for me to be able to be free, to come from early in the morning to late at night, because I had to travel an hour each way, so that tied me up ten hours a day and with a family, that's hard to do. OK, so by getting that money, he could go to camp. He probably would have gone to camp anyway, but this way I could be assured that he was taken care of and the money really did help. I have to say for myself that it really helped. Number two pragmatically, it gave me credits and the credits helped me finish my physics certification, but regardless of how it was in terms of the pragmatics, um, honestly the quality was there and that's what made me keep coming back. That when I finished with it, and then resumed teaching, I saw that I was better prepared for my students' questions, and it was easier for me, actually to look at other books, because my first certification is chemistry, so that's the stuff I can go yup, yup I can remanipulate any lab, reinvent the wheel. I can do anything in chemistry, with my eyes closed. When it comes to physics, which was my minor in college I have to work harder at it to be a good physics teacher and um, every year that I have finished UPDATE, I have felt much more confident. You know, sincerely, having taken the program, and I've done Bates, I've done physic's institutes at Bates, and I've found those also were really excellent and I did a Woodrow Wilson and I found that was really good, but I find there's a lot of junk out there too, and this one's, always been like "Oh yeah I'll go to this one every year."

Daniel — Obviously, money is always a major factor, but there's also the topic each year, I'd look at the topic and say, all right, yeah, how much do I know. Yeah I know a certain amount there. And each time, I've got to admit, no matter how much I knew in the topic, there was more that they brought in or at least it seemed that they were willing in each case, the presenter were willing to say all right what do you, uh know and they try to meet each of the people at whatever level and maybe give a little bit more, if you needed more on a certain topic or whatever. Um, you know everybody has been real good about the organization. I've done a lot of different programs where you do it and by the, you know, no matter what they talk about during the program, when the last day came that was the last day of it. You didn't hear from them you didn't see them, you know. You were glad. But, but in this one there is the follow-up, which is really nice. I mean, sort of, like Brendan was saying, as far as going through it and, um, yeah, you would talk to other teachers and see what their doing in other school systems, what do you do in classes, things like that. You also come away with demonstrations and labs and such, that you can bring back into the classroom, modified, you know the things they might do at the college level but you're not going to do it the same way, but you can get an idea for something to do with your classes as either a demo or a lab, so there are a lot of things that way and the fact that there was a follow-up, um, you know during the school years so you can come back and talk to other people and see what was going on too. I think was a factor.

Researcher — Do you think your participation in the program has affected your physics teaching?

All — (Yeah, yeah.)

Brendan — It probably has broadened my knowledge.

Allison — I've put some things in from what we've done. You can't put everything in, that's impossible.

Corrine — Teaching is an isolated thing. I am the chemistry teacher, and there is the physics teacher, maybe one more here and there in a bigger school, and bringing twenty-four people together, it's much easier to go, oh yeah, he says that he has that problem and she says that she does that better than what I'm thinking of doing. There's an awful lot of that, that goes on to and I like that. It validates the way I do things and it helps me change and rethink things and that's great being around people who do the same things.

Brendan — Oh, it's nice to be with others and we're all in the same boat. We learn from others.

Daniel — It also, no matter what knowledge base you have, getting something more. Because you do, you bring it like you were saying, you bring it back into the classroom and most of it is off the cuff. You never think about it until after and you say oh yeah I just learned about this last summer and there it is.

Researcher — So enrichment.

All — (Yeah, yeah)

Brendan — And feedback too. You sometime might say, oh I saw him do something and then I tried it and say, "gee it worked out pretty well". You get similar feedback for something you may have done.

Corrine — And it's different from going to the alliance meeting, which are very good or any AAPT meeting, or whatever else. This here, we're all working together as lab partners and we develop a bond. If I had a problem with what I was expected to do I would feel very comfortable to call up any guy or girl and say 'I've got this idea and this looks really good and I'm stuck,' but if I met anyone just through an alliance meeting, I'm just shy to feel that I could impose on their time.

Researcher — So, have you changed your curriculum because of UPDATE? Added more, subtracted things?

Corrine — I've put in a lot more thermo-chemistry, last year in my honors chemistry class and I could do it faster than if I had done it on my own, because I had a very difficult chapter and it flowed much easier.

Brendan	I haven't made a firm commitment to change curriculum but I see the probable need to do different topics or spend more time on topics, that I hadn't in the past, and I think the program will allow me to do that a little easier.
Researcher	So, in other words it's UPDATE topics you're talking about?
Brendan	Oh yeah. Things are changing everywhere, it just gives us a chance to put some things in, we didn't know, yeah.
Daniel	Yeah, I would say I won't be changing whole curriculums, but individual lessons or individual labs change.
Researcher	What do you think are the most important things that you've gained from the program overall have been?
Brendan	Probably for me the single most important thing is being in contact with more people, because I'm in an isolated community, uh with no large city around, with no major colleges around, nothing around, and it gives me a contact with Lowell, where I can borrow equipment. Some of the things, with a small budget, we can't afford and I probably wouldn't feel too uncomfortable asking someone if they had some equipment at their school I could borrow. I did borrow some physics books from one of the people in the program, because I had too many students last year and not enough books, until I can order some more. Um, so It gives me more contacts and I think that is the most important thing for me.
Corrine	Everything I've said before, but to add to that the Alliance to the college is real important. Uh, Arthur and Dave are very, very helpful and the fact that I have a better perspective on what my kids are going to be doing when they get there especially as physics students and as their going through the program as physics majors. Uh, working with the kids that are lab aids and the doctoral students, the kids that are in the program, you just benefit from seeing what their struggles are, uh all the way through. I can see which kids of mine are

better suited to that than others or who is that I wouldn't have thought of.

Brendan — I think the professors at Lowell have now realized what high school teaching is all about.

All — (Yeah, yeah)

Allison — I've seen it. I've seen it because I think when we first got involved with this my first year, they kind of said, "what's life like?", and I've been with the same people three years now developing great friendships and I've got to know these people and as a student I was always afraid of the professors, this guy knows more than I do, this woman knows more than I do, but now it's like a one on one relationship and I find they're regular people. They now realize, I think after three years, they now know what high school teachers have to work with, how we're doing it and that's where we've finally got to.

Brendan — With the liquid nitrogen, they thought we could bring those labs in and do them right in the high school and I said those kids will be sipping that stuff. "They wouldn't do that". Yes they would. (chuckle)

Allison — I did a demo with liquid nitrogen, just for the kids. Yeah, some of the stuff yeah, I think the first year they got some labs in there that there is no way. We couldn't do this stuff, we don't have the equipment, the time and I don't trust kids with some of this stuff. So this year we've got some things, that all of us have said "hey, I could use that." So, that's what I've seen.

Corrine — And I think they learned high school teachers don't have the same flexibility as they do. I can't just go to some phone sometime during the day and call Ron out and chat about something, and you know there was quite a culture shock for them to understand we just don't fax things to one another.

Brendan — We're on a very tight schedule, I think that's what they've learned. We have five classes, we have a prep, we have a duty, we have to be some place, we have kids to worry about, we've got problems they'd never see in a college setting. You know these are the problems we have to deal with, you know attendance problems, this that, I mean teaching college, I'd love to try it. I don't know.

Daniel	It's definitely been a two way street, that originally, they thought they we were going to do something for the high school teachers, but now I think it's much more of a give and take. They see our areas of expertise as well as the things that we need help with. I think there's been more give and take on both that way.
Allison	I agree
Researcher	You may not be aware of the goals of the program, but the program directors have indicated there are five goals. I'd like to read you those goals and I'd like you to comment on whether or not the program has met its' obligation to those goals. And any kind of comments you want to make about that are appreciated. The first one is to provide participants contact with professional physicists and astronomers. The second one is to promote networking, to reduce isolation among physics teachers. The third is to provide an opportunity for participants to learn physics. The fourth is to provide an opportunity for participants to enhance laboratory skills. And the fifth and last is to provide new ideas for teaching physics.
Brendan	I think they've done pretty well.
Daniel	I was just going to put together what we've been saying and there they are.
Allison	No problems with that, uh, I think they have achieved it.
Corrine	On a scale from one to five, I'd say five, five, five, five, five.
Brendan	I think on numbers one and two there that was exactly what I got the most out of.

Allison	If that's what was intended, if that's what the goals were that were intended from the very beginning they've got that. You know sometimes these programs are set up and never get where they want to get.
Corrine	Just on the side, we have a friend, Bill and I, who is here, at U-Mass doing a biology workshop. I shouldn't have said, it's confidential and when we were having breakfast or lunch with her the other day, we showed her our schedule and a little bit of the description, she was so flabbergasted and jealous, and she went back and told her friends that while they were doing one of their things, what the physics group was doing and she said that they all wanted to come and join us. They felt they were having a wasted week.
Allison	If we're going to be out here, if you're going to keep a hundred people amused, you better keep everyone busy (chuckle), because you know that's how it is. It's like OK. we're going to try to keep the kids amused, that's what I thought.
Corrine	And you can't love it all, but like I say [to] my students, you might not think I'm great everyday but you know I try. You may not be thrilled with every lecturer, but here's a lecturer for us and he's trying, and we tried to get one and that's all you can ask for.
Researcher	Do you think your participation in this program has affected your students?
Corrine	Oh yeah.
Researcher	How's that?
Brendan	I did a demo the first day of school last year, partly from the lab and the kids were fascinated by it and I followed up on it later, because it became part of my project. I had to formalize it, later and it was one of the better ones that I did all year, as far as the kids were concerned. They really wanted that and wanted to keep it going. I didn't set up enough time, I should have done it longer.

Allison	Yeah, whatever hands on stuff you get them to do in class, it's better than sitting there and boring them to death with lectures and stuff. They do need, I'm in favor, they do need some lecture material, I mean you hear all this new stuff, get away from the board, get away from the notes, get away. They do need that, but this gives a lot of opportunity to bring these hands on stuff to the kids, they can see this, wow. "Whoa, it works", you know. So that's what I'm seeing.
Brendan	It's also an opportunity to give. We don't actually have an honors program anymore, but I offer honors credit for students that are willing to do some additional work and having some of these labs which I have not actually tried out in the lab setting in the high school allowed me to let kids try them, you know, and see how they work for them and it was good, it was good in that respect too.
Daniel	You do get kids that you could give advanced or independent projects. A lot of the stuff could be used for that.
Researcher	Was there anything in the program that was missing, uh that you sort of expected but never happened?
Brendan	Local parking. (Chuckle) (Especially here.)
Allison	Well, last year was a disaster with the meals, the dining hall.
Brendan	You're talking about the actual program.
Researcher	Yes.
Daniel	The one thing that is during the six meetings when we get into projects. Last year at least when we were given them it was sort of like, the idea was work as a group on a project and then as the time progressed it seemed like everybody was working on individual projects.
Allison	Yeah. That part didn't work. Uh, and that's the only negative thing I have to say. Um, the meetings, yeah I, the first year the six meetings we didn't know what to

do. I mean, uh we'd get there and we'd say OK. what are we going to do? You know and uh, that was just a drag. And last year, OK. we got a little more organized, they put us on a schedule. Uh, I think six meetings is too much, um and I wrote that down. I could do it in four, maybe three. I don't know.

Brendan	If some of the participants would have their stuff together, (heh, heh), by the deadline assigned, right.
Daniel	It's also what really to do during those things. I mean you could also use those six instead of working on a project, to do like field trip type of stuff.
Brendan	Like the one we did at the mill.
Allison	Yeah, the mill. I agree.
Corrine	Like the Amtrak that one time.
Allison	Right, right. Maybe a chance to take some of the labs and re-explore them and talk about the data, why did it come out that way. I don't know I'm just thinking of things like that. Yeah, they put us on a schedule now that they want a project done. These are the timelines which is good because the first year was like, up in the air and then finally it all came together. So they want to take something, it's hard to work with a group to meet. Everyone has tough schedules. Um, so now they've said to us everybody develop something and maybe someone else can test it and we can share our ideas. So that's how it's come full circle. They first started out saying, 'one project per group, you people meet and get it together', it just didn't work and they realized, our people at Lowell said, 'all right it's not working', so that's it.
Researcher	Have there been any surprises in the last few years, like something you didn't expect, never expected to get out of the UPDATE program, yet you did?
Brendan	Yes I'm sure there is and I'll try to think of it. (chuckle)

Corrine	Not a surprise, surprise, but um I'm pleasantly happy about the fact that during the year there were lots of things that would pop up in my mind. You know you're always searching, like how are you going to capture their interest and I could say, you know when Mike Mullane said such and such about up in space this is what we're demonstrating here.
Brendan	Millitech.
Corrine	Millitech. Several times I said, the way they use computers to assimilate what they needed to do for the communications. Um, there were just many, many things I would bring up. Talking about the radar and the telescope, it was really nice to say I've seen this, I've talked to this person. Phil Morrison, the guru, to be able to say I have met this gentleman and he knew all these scientists that were so very famous and he's a living relic and he's still around.
Allison	Yeah, just to meet an astronaut. I still can't believe I did it. (The kids love that) I shook his hand and I go "wow". I don't know I was a kid, I was a kid again, I'll admit it. I got his book for my son. It was cool. That's my feeling, I don't know. I was psyched about meeting somebody, who's actually experienced that.
Corrine	It's nice to say you kids will be doing this when you go to college, when you take a physics course and be able to believe it, rather than think I hope I'm not fooling them or they're going to come back and yell at me. Because when have I really been some place and done some of the labs that the freshman and sophomores do, even the juniors. Our assistants were saying I'm going to this experiment when I'm a junior or I'm going to do this when I'm a sophomore, or I did do this when I was a freshman and now I can say you have to know what you need to do for this lab because this will have follow through.
Daniel	It's also interesting, I was just thinking because one of my former students had Art for a professor last year and we were comparing notes on, you know, what I had expected for like write ups and stuff like

that. I had seen and what he was expecting and stuff and it was kind of neat to get that link and know what I'm telling you, you need to do this, here's why.

Corrine That's there buy in. That gives some of them the extra incentive.

Allison That's it, yeah. Exactly, we struggle with them all the time. I don't know, you always tell them, "when you get to college you better be expected to be able to this and this and this and no one is going to hold you by the hand". I don't know.

Brendan I think that's an area we need to discuss further, maybe in those six sessions in the winter. What are physics students expected to do? Because I know my expectations have changed in twenty-five years of teaching.

All Yeah, right.

Daniel Yeah, but if the freshman in college, the kids are going to be expected to do certain things they should at least have experienced something to do with it. Not necessarily be able to do it the way they want them at Lowell, but if they want them at Lowell to do an error analyses, the way Dave talks about it, then at least they should be aware of that as opposed to just relative error, which is mostly what you do in high school labs. That's what I tried to do years ago, but I had to give up so I went back to relative error. (heh, heh)

Researcher There's always a chance that there will be another program similar to this. Looking over all of your experiences with UPDATE, can you identify some of the sort of strong characteristics of the UPDATE program, which should definitely be included in future programs?

Daniel Keeping an open ear, you know. Whether it was like having Larry Lowe there so there was a filter, so what we were experiencing got to the presenters and they, you know, they listened. I mean, you know to what we are saying as far as the changes that everybody is seeing and if they really do listen, here's what is going on and not, I think that factor alone was really important to a lot of us.

Brendan — I think they'd like to associate another program with the changes that are occurring with this Ed-Reform, itself. I think once that Ed-Reform is really put into finalized form, just what needs to be done in K through 12, then a new program might be able to be put in, but I think it's a little bit iffy right now, as far as the situation is concerned.

Allison — Any links between the university system and the high school system would be nice. I think that fulfills a great need. I tell colleagues, teachers that I meet along the way, um, people can't believe what went on in this program. The materials I brought back to my school, my colleagues were like 'wow'. It's like I walk through the school with all these rockets and stuff like that. Last year I had all sorts of circuit boards, I had digital multi-media. It's like Christmas time and stuff like that, that's incredible stuff, so there's been a tremendous amount of stuff like that. I know the funding unfortunately is going to fade away from this, but I'd like to see them do something else. Uh, and, and we were told by our professors that they were going to go back in and try to do something for '97. We hope, because we hate to see something just fade away and never hear from anybody again.

Researcher — So what you're saying is that the kit is a strength of the program.

Allison — It was very important, yeah. I mean it just wasn't do the lab, we can't give you that stuff, we don't have any money.

Daniel — And that's exactly it cause we don't, our budgets have progressively gotten smaller and smaller and smaller.

Allison — You try to put in for something like that and they say, 'we can't afford it'. You're lucky to get textbooks every five to six years, I mean longer than that.

Brendan — Yeah, twenty years, I think.

Daniel	Yeah, so any time you can bring a new piece of equipment in, it really is appreciated.
Corrine	And the stipend because it's a three week program and it ruins a lot people's summer opportunities. I mean one week, that's not bad, but when you're giving a three week commitment, it's a lot of piece of mind. It's is not a fortune, but it's very good and um, to be able to not be thinking about, 'oh I would have been able to do this to pay for camp', or whatever, to keep the little ones safe.
Researcher	Anything else you want to add ?
Corrine	It's sad it's ending!
Allison	Yeah, it's going to hit us, all of us I think. Next summer I'm going to be saying, 'what am I doing ?' (chuckle)
Brendan	It's funny, there were a couple of people who didn't come back this year from last year and we really miss them.
Corrine	We miss them, yeah.
Allison	We've made a lot of good friendships. I've made a lot of good friendships, met a lot of teachers and um, we were kind of disappointed some of the guys from our program didn't come back this year, but we made some new friendships and it's nice, you know. Just to see what else is going on in your subject. You're in your school, you're focused on that and then just step back in the summertime and OK, just take a deep breath and say, 'oh wow there is other people out there, they have the same problems'.
Corrine	Anybody, who's going to commit for three weeks is on the same wavelength. So it makes it easy to form friendships, because you're already committed and care about (you're already committed!) It makes you committed. (chuckle)
Allison	It gives me a chance to say, when people say, 'you only work six months', I can say, 'no, I'm working three weeks this summer.' (chuckle)

Daniel	Yeah, there's probably a lot of teachers out there would say summertime is my time. I don't mind giving up this time and uh, it's going to pay off. I mean that's one person's opinion.
Corrine	I have people tell me I'm nuts.
Allison	That's life. I mean, um, I enjoy what I do. I wouldn't do what I do. I love, I love my job, you know some people hate their job. I love my job and this is fun, I don't know. We call it physics camp. (chuckle)
Corrine	That's perfect.
Daniel	In industry, you actually can take portions of your day and learn about your thing. What we do, we get in on ground zero and you're working the one hundred and eighty - two days and then you stop and if you have to learn anything you have to do it during the summer.

Focus Group Summaries

Summary: Amherst Focus Group

Concerns. The Amherst Focus Group identified several areas of concerns. Primarily, issues surrounding scheduling were frequently cited. Most participants in the focus group thought that the events, particularly daily events such as labs, lectures, breaks, lunch, had been too tightly scheduled in previous years. However, they indicated that this year there was improvement over previous years in that respect. Carl said, "I like the extra time because it gives you a little time to reflect, either with other teachers or by myself to sit down and think about a few things, before we go right into something else."

Other concerns were related to scheduling, such as pressure. The loosening of the schedule in the third year of the program created a feeling of less pressure for Allan, who said, "I feel a lot less pressure this year."

The length of the meetings was also a concern. It was felt that the sessions were too long, that is, too many hours per meeting. In addition, many felt the group work was difficult because it was logistically difficult to schedule meeting times. Often, members of a group would live and work a significant distance from other group members making it difficult to accomplish work as a group. It was also suggested that a lecture may be of interest for the scheduled meetings at the UPDATE campus. Another suggestion was the exploration of "real uses" of some of the topics such as quantum physics during the scheduled meetings.

Finally, the Resource Room, which was a room provided by the Program to house equipment and other resources for participants' to borrow for use in their classrooms, was not yet available. Some participants felt that long travel time to the campus to access Resource Room materials would prevent them from making use of it even when it became available.

<u>What was Valuable</u>. Participants were free with comments about what they thought were valuable aspects of

the program. Concerning the change in schedule for the third year, the following very identified as being valuable: extra time between scheduled events such as lectures and labs for reflection; and more time to network with other teachers. Networking was one of the most cited aspects of what was considered valuable by participants. Allan said, "That's the benefit of coming at least two years, that you do cement some relationships." More time to compete lab activities was valued, as well as the topics. Many felt they enhanced professional development. Dorothy said,

> It was really useful for me because I do a lot of that in chemistry. When I talk about atomic structure so the little bit that Roy did on the bonding was really nice because he got in a couple of things I hadn't thought of at least to explain things. I tried to explain those things, but sometimes I feel I don't do very clearly. Now I have a new way to try that and I hope it works better. I found the stuff really useful.

The stipend was appreciated. For some it allowed them to participate as it filled in lost summer income. University credits provided for participation were considered to be an asset, as well as the hands-on activities, the Kits provided to participants, the inspiration from speakers such as astronauts, and the camaraderie (meeting and networking with other physics teachers, and to a lesser extent, the University staff).

<u>The Effect of the Program on Instruction</u>. Several of the aspects of the program cited above were also identified by participants as making a contribution to their physics

instruction. However, when specifically asked about the program's effect on their instruction, responses fell into only a few categories: topics which provided the opportunity to learn new physics, comfort level or confidence, creativity, enthusiasm, validation of what teachers are doing in their physics classes, and new ideas for teaching physics. Dorothy said,

> Another thing that really made me want to come back was that we were going to do some more with quantum mechanics and that was something I was really interested in and wanted to see how I could integrate that more into my classes and that's not something you can get from very many places.

Most participants cited three sources for new ideas. The first was the demonstrations performed by colleagues; the second was lab activities; and the third was through networking with other physics teachers. Focus group participants also indicated that they are spending more time on UPDATE related ideas in their physics classes. Some also said they had changed their curriculum to include some UPDATE topics, primarily electronics.

Dorothy said,

> I spent more time on electricity and building circuits and stuff because after we did all that work last year on the circuit boards and everything, I felt much more comfortable about how to do that and how to troubleshoot. Like when a kid had something set up and it wasn't working right. That was something that before I was really careful about and did a lot more hand holding and watched what they did more closely. Now I kind of let them go and mess around a lot more.

Unexpected Issues or Concerns. There were few unexpected issues or concerns. One unexpected issue was the change in attitude toward the UPDATE host, the University of Massachusetts. Some participants were impressed with the University of Massachusetts and indicated that they were going to recommend the University to their high school students for consideration. Allan said,

> I mean I've never had a problem selling the University to my students but I think that I feel more aggressive about that now, particularly when you hear a put-down of the state university system. It's unjustified.

Another surprise for many was how understandable the quantum mechanics was made to be in lecture. Participants expressed initial apprehension about the level of difficulty of this particular topic. However, they thought the lecturer did a great job in presenting difficult material. Kate said, "I was surprised by what I thought was a really good job Roy did with the quantum mechanic's lectures, because that's a difficult topic."

Summary: Boston Focus Group

Concerns. The major concerns expressed by the Boston Focus Group were issues around scheduling. Generally, participants thought that the program was too ambitious during the first two years. Comparisons were made with the third year, which the participants found to me much less hectic and stressful. Al said, "it seemed like they tried to do too much. That was just what I got out of it. It was a well thought out program, I just think they tried to do too much."

Other scheduling issues concerned the time allowed for participant interaction. Bill said,

> It would be nice to have the time to consult with the other, you know, the other people in the program, not just the other participants but the staff too. We were running around trying to make things work.

Al said,

> I think it was a lot of the timing, the end of the day, people were tired, long day people want to go home, there not really in the mood to discuss. We tend to do that on our own over lunch. "What did you see? What did you get? Why did you do that?" Possibly, recognizing that and leaving those time gaps in the format so that it will happened on its own.

There were some concerns about the applicability of the UPDATE subject matter to the high school classroom. This concern seemed to be primarily limited to quantum mechanics, which was the topic of the third year. Participants felt it was far more difficult than the topics of previous years and it was more difficult to translate into activities for the high school physics classroom. David said,

> I agree. And I think that, I guess for myself, when I 'm listening to topics and discussions in space physics I see things I can bring back to the classroom very easily. The things in quantum physics, I see for myself, hopefully helping me at some point, someday I might have some inkling as how to deal with it. I don't see that as material that I can transition it to the classroom. Um, at maybe some point in the future.

The Academic Year Meetings were cited by all Focus Group participants as a concern. Most expressed a general unhappiness with the meetings citing a variety of issues. Bill said, "Uh, yeah. I'm not convinced the academic years went very well. At least not in our area."

Researcher	How's that ?
Bill	I don't know, it seemed like we were showing up for meetings and it, just to see what people were working on.
David	If the meetings are during the school year, we lose an opportunity for us to be exposed to additional facilities, events, you know that the university staff is aware of or can access for us because of our association. And at the same time, if it's compulsory for us to be working on these projects, we do need the assistance. Free access to the people who are grading the projects, but to use the projects, or that sort of work as a purpose for assembly, like we said it became a drag, particularly the first year people came 45 minutes late.

<u>What was Valuable</u>. Participants identified many aspects of the program they felt were valuable. The most cited was the opportunity to meet and work with other physics teachers. David said,

> You know it's funny being a teacher. I always remember, I read an article, when I was in grad school, it was called, "The Lonely Physics Teacher." I find that true. I spend most of the day from seven in the morning to three in the afternoon basically by myself. Well, I have the students, but I don't have any other professionals to talk to or maybe listen to a lecture and try to stimulate yourself with something new. So this is kind of a nice outlet.

Other aspects of the program cited as valuable were: (a) the academic rigor and intellectual stimulation. Bill said,

> I'm primarily here for the intellectual stimulation. I'm tired after the year focusing on instructional techniques. I mean the conferences, the workshops I've gone to, they're always talking about techniques of communicating, not what we're communicating. And I need to focus on what we're doing not necessarily just the how. Um, and this is for me, it's not necessarily for my classes. I look for the bridges to my classes, but it's three weeks, uh, it's nice to be a student once in a while.

(b) labs. David said,

> I thought it was, I really liked the lab activities. I thought that another program should not get rid of any of the lab activities. As much as I complained about not having enough time, I really enjoyed myself. Maybe it's just I'm a slower worker, but um I really thought those were the highlight of the day.

(c) field trips. Bill said, "I like the research labs. I like the visitations and the field experiences." (d) the Kits. Cathy said,

> I used my stuff a lot, even I didn't always plan exactly how I would use the stuff, but all of the sudden I would say I do have that stuff and I knew how to use it too. It wasn't a matter of having to say oh wait a minute I'm going to have to go out and buy that myself, which I know would come out of my pocket so that would be an added incentive not to acquire it and then play with it in time to figure it out, but I knew already and I'd be able to set something up and have it ready to demonstrate the next day and that was wonderful. I know I will do that with the material from this year as well. The same sort of thing, I'm already rehearsed somewhat or familiar enough that I can utilize it much better then having got papers or just a demo in front of the room and then I have to put it together.

And Bill said,

> I do have a wish list, although the stuff we were given was really good, my wish list is that every participant would have been given a computer with a modem, with the software to take back to their schools, and an e-mail account or an electronic connection so that the communication could

> continue, not just for a year but for a longer time.

The Effect of the Program on Instruction. The most frequently cited response regarding the effect of the Program on instruction was an increased level of confidence. Confidence was cited in two regards. First, there were several remarks about the level of confidence in relating the subject matter to high school students. This included being able to answer student questions and confidence in the subject matter. Cathy said, "Mostly in questions kids would ask that I might not know the answer to. I feel more capable of fielding questions." Al added, "I feel more confident." And David said, "I feel a great sense of confidence in dealing with a topic."

Secondly, confidence was gained in the ability to ask for assistance. Al said,

> The other thing is if I run into a question I can't answer I can refer that student or I can refer myself to other people, I've met in the program. I've been interfacing with people behind the program, at other universities. I feel more confident to ask for help from people. In the past I would have felt I was revealing my stupidity.

Other effects of the program Focus Group participants cited as influencing their instruction were: (a) re-energizing or gaining of enthusiasm for teaching physics. Al said,

> I guess, basically it's nice to have work in the summer. It's nice to, I guess you could say, to work in your field. Um, it's nice to actually talk. For myself, I'm a fairly new teacher, it's

> nice to talk to other physics teachers and see how they do things. Um, sharpen up your skills a little bit and learn some new things. Um, the topics, very good topics in terms of space physics and the first year was astronomy, By June you're really burnt, I leave a program like this reinvigorated, it's going to help me in August in terms of reassemble and modifications of what I'm presenting this year. So, I see that as probably as greater impact, that's um, going to reenergize things.

(b) enhancement of lab skills. When asked about how successfully the UPDATE program met its stated goals, David commented on the fourth program goal, that is to enhance lab skills. David said, "To a great degree. Lab skills to a great degree."

Finally, when asked about possible changes in their physics classes due to their participation in UPDATE, the comments were mixed. Most participants were reluctant to identify any changes in their physics curriculum. For example, Bill said

> Things change every year anyway. I'm sure I'm not teaching the same way I did two years ago or even last year. And next year will be different. These things become unconsciously part of it. I may have expanded those areas, areas I felt weak in before, but if you're looking for a major change I'm not sure it's there.

And Al alluded to a change in her methods of physics instruction: "I'd say curriculum content, I still cover the same stuff but maybe the methods of getting the content across to the kids is presented differently."

However, there were comments made throughout the interview that indicated that UPDATE related material or ideas were making their way into participant's physics classrooms. David said,

> And I think that, I guess for myself, when I 'm listening to topics and discussions in space physics I see things I can bring back to the classroom very easily. The things in quantum physics, I see for myself, hopefully helping me at some point, someday I might have some inkling as how to deal with it. I don't see that as material that I can transition it to the classroom. Um, at maybe some point in the future.

Bill added,

> I actually talked to scientists and engineers that are working on the day to day problems of finding out the answers to the questions being posed, um I like to see how science is done in the real sense. Not just what we get in, you know our textbooks are very antiseptic, if I could bring back to my student that feeling. I need to renew my feeling to the way science is done. I don't get it by staying in my classroom. Um, it's an area I think is important. In the past, I would have been afraid of that. I thought of researchers as being really out to lunch, uh, nothing is farther from the truth. Um, I would crave that and look forward to be able to share that with my students, either directly by taking them to similar experiences, or uh in a secondary fashion, by telling them what I experienced.

Unexpected Issues or Concerns. The researcher identified two major issues that were unexpected. First, as with the Amherst Focus Group, participants expressed a change in their initial conception of the University of Massachusetts. David illustrated, "I think one thing that has happened is the rebuilding of my misconception, in terms of U-Mass. I'll be honest with that and I know I convey that to my students." Secondly, participants were surprised at the willingness of University staff to assist high school teachers. Al said,

> Yes and their willingness. At some point that becomes very accessible. I didn't expect that. Between the staff at the other Universities and certainly at Boston, certainly at all the different schools. The uh, their accessibility. I mean everyone's leaving their information in terms of if you need to contact me and if you have questions about these things and if you want to bring your kids in.

<u>Summary: Dartmouth Focus Group</u>

<u>Concerns</u>. The Dartmouth Focus Group expressed concerns in two areas. The first was a general feeling of disappointment with the third week of the program, which took place at the Amherst campus. Amos said,

> I didn't find the third week as good as the first two weeks. Always at least one of the two lectures wasn't good and, uh, there's also a tendency to present certain aspects of the topic which aren't as useful to us. I mean there will always be some very specialized aspect of the topic that the guy got into, even the coherent one, there's always one that isn't, every year. Didn't seem as useful to me as the stuff at the home campus, which was always directly related to what we need.

The other area of concern was the Academic Year Meetings. Most comments regarding these meetings expressed the sentiment that the meetings were not useful to participants. Don said, "I found the winter part difficult to do during the school year. I found it hard to do properly. It bothered me."

Researcher If you had a chance to change that, how would you do it?

Carla Not do it. Either not do it or do it at the end of the summer. I mean, people don't realize that during the academic year, high school teachers are under tremendous time pressure.

<u>What was Valuable</u>. Focus Group participants found numerous aspects of the UPDATE program of value, including (a) the professional staff; participants found the professional staff the be well organized and prepared, excellent models of teaching, accessible, and concerned. Carla said,

> I thought they were all extremely well prepared, you know all their notes were ready and if they had any demos they were ready, they just had everything ready on time. I'm really happy they dealt with us as individuals.

Amos added,

> One of the things that I was impressed with was that all of the professors were there all of the time. I thought because we had different topics each day might be that the professors would come in every other day. But they always popped in and out. Even when we were doing labs, the space person would be there to see what was going on in the quantum lab. They were very much concerned with pulling it all together. I was kind of impressed that they would be there all day long.

And Brenda said,

> Yeah, definitely. I feel as though they accept us as peers, they're wonderful, really wonderful.

(b) labs. Amos said,

> I like the labs because you got to do lots of things which you probably would not likely do in a high school setting because of basically the expense of the equipment, also a lot of the labs, when you were all done you could pack the stuff and take it home and now have this new little toy thing to do with your kids back at school. Just being able to have that bag of things, not oh well there's something else that if I bought it or made it I'd have it, no you had it when you

left. I think the experimental part is really important. All the demonstrations when we go to campuses, we have the labs that are presented in the first two weeks. So there's a lot of experimental physics you can catch if you pay attention.

(c) Kits. Carla said,

> I used my stuff a lot, even I didn't always plan exactly how I would use the stuff, but all of the sudden I would say I do have that stuff and I knew how to use it too. It wasn't a matter of having to say oh wait a minute I'm going to have to go out and buy that myself, which I know would come out of my pocket so that would be an added incentive not to acquire it and then play with it in time to figure it out, but I knew already and I'd be able to set something up and have it ready to demonstrate the next day and that was wonderful. I know I will do that with the material from this year as well. The same sort of thing, I'm already rehearsed somewhat or familiar enough that I can utilize it much better then having got papers or just a demo in front of the room and then I have to put it together.

(d) networking with other physics teachers. Brenda said,

> I don't know what's most important to me. The enrichment probably primary but second is the interaction with other physics teachers. I always say teaching physics is a lonely job. You very seldom get to play ideas off of other people and just the sense of humor someone with physics training has, is a little unusual too (chuckle). I mean interacting at that level as well. That's wonderful, making connections because you network with teachers from all around and there really is a bonding, that's wonderful. And with the instructors as well, very much so.

(e) inspiration. Brenda said, "Inspiration. In general that would encompass it. And to see really good stuff going on with a lot of other people, really neat ideas." (f) certification. Carla said, "I like interacting with all the high school physics teachers, I got a lot of ideas from them. Even exchanging war stories was good, you finally realize you're not alone. Also certification."

<u>The Effect of the Program on Instruction</u>. When asked specifically if the program has affected their teaching, the Dartmouth Focus Group was unanimous in their agreement. Several effects were cited: (a) validation of teaching practices. Carla said,

> It reinforced my belief that hands on is extremely important because there's a lot of pressure to do the traditional you know equations and do calculations and that's it. And time in schools and budgets now keep putting pressure on doing less experimentally and it made me personally stronger to say no, we have to have the money or I have to go through the struggle to have the kids do more hands on. The other thing I found the first couple of years I taught astronomy, people would say it's not a lab science, it's not a lab science and I think after the first time I came to UPDATE, I said, "it's going to be a lab science" and the labs I've incorporated in the last couple of years have been truly amazing. Just from ideas that I got and all the toys that I got, um, very, very weak on electronics and the first time we had to do something with the board. I'm still not very good at it, but at least I know what it is.

(b) enhancement of knowledge base. Don said, "Maybe more sophisticated, I think you just have more knowledge." (c) re-energizing. Amos said,

> To some degree I find it re-energizing. I certainly wouldn't come back here the second time if it was a continuation of what I had done all year long with my kids in school, uh, it's completely different. I went up to a vacation place with my brother and sister and they had their sons and daughters, so they're my nieces and nephews and they ask what I've been doing and I say I've been in school and it freaks them right out. (ha, ha) Yea, and I'm doing it because I want to. (Ha, ha).

(d) changed high school physics curriculum. Although most participants said that they made no significant changes in their physics curriculum, there were indications that some changes were taking place. Amos said, "Is this going back to my curriculum supervisor ? (chuckle) I have a curriculum supposedly, but I never look at it. We can do whatever we want, whenever we want, the way we want, it's really a nice thing." The researcher asked, "So you haven't made any wholesale changes, for example, thermo-dynamics is really important so I'm going to add a whole section, nothing like that?" Amos responded, "Well, just small additions to what I already do." Don added, "Not really big changes." And, Carla said, "I didn't add units but I added a demo here and there and I do a little more with electricity."

Unexpected Issues or Concerns. One issue was identified regarding the composition of the UPDATE program. An appreciation was expressed for the scientific nature of the UPDATE program. Carla responds to a discussion of the goals of UPDATE and how successful the program was in meeting its goals:

> Which brings me to something I want to say just in case you don't ask it. This program is refreshingly free of psychology. This is what's wonderful about this program, it's all physics. It's not all that Ed. stuff. It's not about psychology.

Summary: Lowell Focus Group

Concerns. Many concerns were expressed surrounding issues of scheduling. Those issues primarily concerned the first two years of the UPDATE program. Comments from the Lowell Focus Group indicated the issues concerning scheduling were addressed by the program directors and improved for the third and final year of the program. Brendan said,

> This year I thought it was very well organized as my third year in the program. Everything was kept right on time, uh, the lectures though sometimes time were a problem, uh, we were able to get through the material. Uh, the labs were pretty well structured, so by the third year I think things were all worked out.

Daniel said,

> I think they tried to address the concerns we had of the previous year. I think they did a very good job of that. I was only in last year, not the first year but probably last year to this year they tried to address the problems that we felt as teachers, as participants the problems.

The Researcher asked, "What are some of those things?"

Allison replied, "Time considerations, the amount of time."

Daniel added,

> Yeah. They were really good at that. Particularly if they knew that a lecture or something was going to run late, it seemed like the lab we were going to have during the next block was a shorter lab, so that we weren't always in a state of rushing, we could actually take some time to do it and talk with each other and not just trying to get the data down or try to get to lunch or something.

And Corrine said,

> Yeah. It's hard to be intensely involved in something from 8:30 in the morning to 4:30 in the afternoon and have that same, uh, high peak of interest, and being able to pay attention. And the first year, one thing they tried very hard to do was pack it with lot of things for us to learn and a lot of things for us to do. And through the years they modified their approach so that we could handle it. So that we weren't over tired,

> over stimulated, but they had that positive intent of trying to give us the maximum and you can't, you can't from 8:30 to 4:30 straight and then back up time, so lose lunch because you've got to make up time and don't have a break. They had all that good intention but they just got a little carried away. And that, um, is an amazing thing to say about a program, that it was so good that they had to like scale back a little bit to give us down time.

Another concern was the level of instruction. Many thought it was not challenging enough. Allison said, "I think that they were perhaps thinking the teachers would be coming in with a little less knowledge than the group that I think we have, happens to have." Brendan added,

> For someone teaching twenty plus years, I'm sure some of this stuff was repetitive, but I'm new to the physics field so I learned a lot, and uh, so I took it from that end. So we had a wide spectrum here. I can see a twenty-five year veteran coming in and saying I know some of this stuff. But some of the lectures probably went way over some peoples' heads, some other lectures, people said "Oh I understand what's going on."

The other concern surrounded the Academic Year Meetings. Most felt that the time spent in group work were not the best use of the time, and were difficult to schedule outside the program. Daniel explained,

> The one thing that is during the six meetings when we get into projects. Last year at least when we were given them it was sort of like, the idea was work as a group on a project and then as the time progressed it seemed like everybody was working on individual projects.

Allison added,

> Yeah. That part didn't work. Uh, and that's the only negative thing I have to say. Um, the meetings, yeah I, the first year the six meetings we didn't know what to do. I mean, uh we'd get there and we'd say OK. what are we going to do?

> You know and uh, that was just a drag. And last year, OK, we got a little more organized, they put us on a schedule. Uh, I think six meetings is too much, um and I wrote that down. I could do it in four, maybe three. I don't know.

<u>What was Valuable</u>. Participants of the Lowell Focus Group were very enthusiastic about the program and cited several aspects of the program they felt were valuable: (a) field trips. Corrine said, "I like the tours." Allison added,

> Yeah, we did the field trips last year, which were a very long days. I mean last year was very regimented, we were on a tight schedule and uh, the weather was nine thousand degrees inside. Everybody was just kind of dragging, not everybody, but Friday, uh couldn't get here soon enough. But this year is more relaxed, more free time. Obviously they couldn't have built in any field trips depending on the topics, but people seem to be a little more relaxed this year.

Corrine added, "I like the field trips." (b) the topics. Allison said,

> The space topic, that's why I decided to come back this year. It's fascinating. I could have listened to Mike Mullane all week and then I'm looking forward to Janice Voss. Um, I've always been fascinated by that kind of stuff. Quantum, yeah, it's uh an interesting topic, but it's hard to make it appealing.

(c) the demonstrations. Brendan said, "I find the demonstrations to be very good. Particularly last year the hour we had with Karl." (d) the labs. Brendan explained,

> Personally, I get a lot out of the labs. As I was just saying. I don't think I get quite as much out of many of the lectures, but you also get a lot out of talking with the other people, you get a couple of labs that aren't even presented, you get demonstrations, watching other people do demonstrations, you get ideas from those. And, uh, I won't hesitate to say that this is the first time in I don't know how many years that

> I've gone back for credits and actually been reimbursed for them. And, uh, I gladly gave up three weeks of the summer for this.

(e) networking with other physics teachers. Allison said,

> We've made a lot of good friendships. I've made a lot of good friendships, met a lot of teachers and um, we were kind of disappointed some of the guys from our program didn't come back this year, but we made some new friendships and it's nice, you know. Just to see what else is going on in your subject. You're in your school, you're focused on that and then just step back in the summertime and OK., just take a deep breathe and say, "oh wow there is other people out there, they have the same problems."

Corrine added,

> Anybody, who's going to commit for three weeks is on the same wavelength. So it makes it easy to form friendships, because you're already committed and care about (you're already committed!) It makes you committed. (chuckle).

(f) the professional staff. Corrine stated,

> The people at Lowell have worked very hard at putting their booklets together for us. I couldn't have, uh, if I had to do that for on my high school level, come up with something, there would be days that it might be good and there would be days when I'd be putting the kids to sleep. But there were volumes of information for us to take what we could and they stayed steady with that for the three years, and they worked really hard at it. I know how hard it is to put together a lab and how hard it is to do it for twenty-four people, so, um, I commend them on that.

Allison also said,

> Yeah. We as teachers appreciate that and we complemented our staff at Lowell. Um, it was very hard, and I've always seen great time dedication to it. Some of the labs, we had difficulty completing in the two hour time block, um, some of them we were able to get done. It's hard and, uh, it works overall. The lecturers this year were pretty self explanatory, they include bibliographies and stuff, where this

stuff is coming from, so no real complaints there.

(g) Kits. Allison said, "It (the kit) was very important, yeah. I mean it just wasn't do the lab, we can't give you that stuff, we don't have any money." And Daniel added, "Yeah, so any time you can bring a new piece of equipment in, it really is appreciated."

<u>The Effect of the Program on Instruction</u>. When asked specifically if the program has affected their teaching, the Dartmouth Focus Group was unanimous in their agreement. Several effects were cited: (a) validates teaching practices. Corrine said,

> Teaching is an isolated thing. I am the chemistry teacher, and there is the physics teacher, maybe one more here and there in a bigger school, and bringing twenty-four people together, it's just, it's much easier to go, oh yeah, he says that he has that problem and she says that she does that better than what I'm thinking of doing . There's an awful lot of that, that goes on to and I like that. It validates the way I do things and it helps me change and rethink things and that's great being around people who do the same things.

(b) useful in physics classes. Daniel said,

> Like what Brendan was saying, I think a lot of it, I think a lot of the experiences that come out of this thing can go right back into your classes. It's not that we are going to bring quantum and bring it wholeheartedly into the classroom, but when you're going through things, there are now things you can draw in, and you know, like with space, here's how this is used there and here are examples. Because a lot of the kids just go, "well why do I need to learn this, or where is this used, or why?"

Corrine added,

> Um, all of that (field trips) is just a great background for the classroom. I brought a lot of

> that stuff back into the classroom. It was really of interest to the kids. It was something people really do. That was a tremendous help, I thought.

(c) enhanced knowledge base. Brendan said, "It probably has broadened my knowledge." And Daniel added,

> It also, no matter what knowledge base you have, getting something more. Because you do, you bring it like you were saying, you bring it back into the classroom and most of it is off the cuff. You never think about it until after and you say oh yeah I just learned about this last summer and there it is.

(d) changed physics curriculum. Corrine said,

> I've put in a lot more thermo-chemistry, last year in my honors chemistry class and I could do it faster than if I had done it on my own, because I had a very difficult chapter and it flowed much easier.

Brendan added,

> I haven't made a firm commitment to change curriculum but I see the probable need to do different topics or spend more time on topics, that I hadn't in the past, and I think the program will allow me to do that a little easier.

And Daniel said, "Yeah, I would say I won't be changing whole curriculums, but individual lessons or individual labs change." (e) use in classroom. Brendan explained,

> I did a demo the first day of school last year, partly from the lab and the kids were fascinated by it and I followed up on it later, because it became part of my project. I had to formalize it, later and it was one of the better ones that I did all year, as far as the kids were concerned. They really wanted that and wanted to keep it going. I didn't set up enough time, I should have done it longer.

Allison contributed,

> Yeah, whatever hands on stuff you get them to do in class, it's better than sitting there and boring them to death with lectures and stuff.

> They do need, I'm in favor, they do need some lecture material, I mean you hear all this new stuff, get away from the board, get away from the notes, get away. They do need that, but this gives a lot of opportunity to bring these hands on stuff to the kids, they can see this, wow. "Whoa, it works," you know. So that's what I'm seeing.

Brendan added,

> It's also an opportunity to give. We don't actually have an honors program anymore, but I offer honors credit for students that are willing to do some additional work and having some of these labs which I have not actually tried out in the lab setting in the high school allowed me to let kids try them, you know, and see how they work for them and it was good, it was good in that respect too.

<u>Unexpected Issues or Concerns</u>. There were two unexpected issues raised by the Lowell Focus Group participants. The first was the clear expression of the importance of the stipend offered to participants. Allison explained,

> There were financial considerations. I'm going to be straightforward. Yes, of course the financial rewards were too good to pass up. I was looking to, uh, advance my physics background, um, the money was there, why not. I did it for two years and I was on the fence of coming back this year, but I said what the heck. Who knows when an opportunity like this, is going to come again. As it turns out, I'm going to get eighteen credits in physics for probably one third of the price, so, um, those benefits are good. So who knows when something like this will come down the Pike again, so I grabbed it.

Corrine said,

> Yeah, very pragmatically, I have a little one and he had to be in camp for a month in order for me to be able to be free, to come from early in the morning to late at night, because I had to travel an hour each way, so that tied me up ten hours a day and with a family, that's hard to do. OK., so by getting that money, he could go to camp.

> He probably would have gone to camp anyway, but this way I could be assured that he was taken care of and the money really did help. I have to say for myself that it really helped.

The second unexpected issue was less of an issue but more of a perception by some members of the Lowell Focus Group that the program has given them a better understanding of what college physics is like. They find it important to understand what students taking physics in college are going to be doing so they have a better idea of how to prepare them in high school. Corrine said,

> Everything I've said before, but to add to that the Alliance to the college is real important. Uh, Arthur and Dave are very, very helpful and the fact that I have a better perspective on what my kids are going to be doing when they get there especially as physics students and as they're going through the program as physics majors. Uh, working with the kids that are lab aids and the doctoral students, the kids that are in the program, you just benefit from seeing what their struggles are, uh all the way through. I can see which kids of mine are better suited to that than others or who is that I wouldn't have thought of.

CHAPTER 6

INDIVIDUAL INTERVIEWS

Reviewing the interview data from the previous four focus group interviews, there are clearly commonalties. The data suggest that participants felt similarly about many of the major aspects of the program discussed in the interviews.

Most concerns were centered around the program schedule. Participants felt the program was too ambitious in its attempt to schedule program activities such a lectures and labs. However, most agreed that the problems around scheduling were largely addressed by program administrators resulting in a good deal of participant satisfaction with the third and final year of the program. Another concern cited by some participants was the Academic Year Meetings. There seemed to be a general sentiment of dissatisfaction with the meetings. The most common concerns about the Academic Year meetings were that they were too long, too frequent, took too much time out of busy teacher's schedule, and the required group work was viewed as somewhat unproductive.

The aspects of the program participants found valuable were also very similar among the four Focus Groups. The most commonly cited aspects of the program the participants found valuable were: (a) labs; (b) demonstrations (both by other teachers and lab instructors); (c) Kits or materials participants received to take back to their schools and (d) networking with other physics teachers. Other aspects of the program that were cited to a lesser extent were field trips and the academic rigor of the program.

When asked about the effect of the program on their instruction, focus group responses were also quite similar. The most frequently cited effects of the program on the instruction of Focus Group members were: (a) validation of teaching practices; (b) enhancement of confidence in physics; (c) renewed or enhanced enthusiasm for teaching physics; (d) enhanced laboratory skills; (e) changed high school physics curriculum; and (f) increased use of hands on activities in their physics classes.

The focus group interviews yielded few surprises. The most common outcome participants identified as unexpected was their changed impression of the University of Massachusetts. Participants indicated that their impression of the University of Massachusetts had risen and that they would recommend the University to their students for continuing their education after high school.

In general, responses from all four Focus Groups were strikingly similar. The aspects of the program participants found valuable and what they identified as affecting their physics interaction, were nearly the same from group to group. The Focus group interviews were a valuable tool in generating general discussions about the UPDATE program. The open format allowed participants to speak freely with the researcher, as well as their peers, and discuss any aspect of the program they felt needed discussion. The uniform agreement of the focus groups was used as an indication of those aspects of the program that may warrant further examination. To explore the topics generated by the focus groups four individual interviews were arranged. One participant from each UPDATE campus was randomly selected and interviewed. The questions generated for use in the individual interviews were largely constructed based on the general information provided by the focus groups.

The Focus Group interviews generally indicated that participants were taking UPDATE ideas and material back to the physics classroom and that teaching practices were changing either by instructional method, curricular changes, or both. Considering this and the specific aspects of the program the focus groups identified as important, general categories can be established which may help to classify the individual interview data. This may assist in determining the extent to which UPDATE has affected the work of the participant being interviewed.

The following five categories will be used to classify the individual interview data: (a) Products: Specific examples of student generated work which were UPDATE related; (b) Physical Resources: The use of UPDATE materials in the classroom, such as teaching units, equipment from Kits, or items from the Resource Center; (c) Ideas/Concepts UPDATE related ideas or concepts used in the classroom; (d) Skills: Skills gained in UPDATE used in any activity, or lab; and (e) Attitude: Teacher or student attitude towards physics or physics teaching that can be attributed to the teacher's participation in UPDATE.

The important aspects of the UPDATE program as well as the effect of the UPDATE program on participant's instruction which have been identified by the focus groups can all be placed in one or more of the above categories.

Products

This category includes specific examples of student generated work. Evidence of student work which is UPDATE related would be strong evidence the UPDATE has affected the instructional practice of the teacher. Examples of student generated work may be a lab activity, paper, project, demonstration, presentation, or any outcome of exposure to UPDATE related ideas.

Physical Resources

Physical Resources are tangible materials used in the classroom which are directly related to, or have come from the UPDATE program. Examples may be the use of equipment from the UPDATE Kits such as multimeters, teaching units developed by participants, lab activities, demonstrations, or equipment borrowed from an UPDATE Resource Center.

Ideas/Concepts

The use of UPDATE related ideas and/or concepts in a high school physics class is clearly an indication of the effect of the UPDATE program on the participant's physics instruction. Indications of the use of UPDATE ideas or concepts may be an inclusion of more UPDATE related topics, the use of lessons developed during the UPDATE program, discussions, demonstrations, and lab activities.

Skills

The UPDATE program offered participants the opportunity to enhance, and in some cases develop for the first time, laboratory skills. Examples of such skills are breadboarding, proper use of highly technical laboratory equipment such as oscilloscopes, data analysis, and the general ability to use common equipment found in the physics laboratory.

Attitude

This category refers to the participant as a teacher as well as his or her students. Examples may include, changes in enthusiasm for teaching or learning physics, changes in confidence, changes in teaching methods (which may be due to a change in confidence or enthusiasm for the subject matter), a change in the amount or frequency of networking with other physics teachers/university staff. This category may also include the willingness of the teacher to change methods of teaching or make curricular changes.

Interview data which can be classified into one or more of these five categories may be indicators of the extent to which UPDATE has influences the participant's high school physics instruction. Therefore, the questions constructed for use in the individual interviews were developed to allow the interviewee to discuss their teaching practices in terms of these five areas. Other questions used in the individual interviews were constructed to allow the interviewee to discuss any aspect of the UPDATE program he or she wishes, as well as to identify those aspects of the program which were particularly useful in enhancing instruction.

The interview format was open and semi-structured. The researcher used a general set of questions for each of the four interviews. However, the interview discussion were not be limited to the predetermined questions. Interviewees had the opportunity to raise and discuss any aspect of the UPDATE program, experience, or subsequent effects as he or she felt was appropriate. The general set of interview questions used for the individual interviews are provided immediately before the first individual interview as well as in Appendix B.

Each interview took place at the location of the interviewee's choice. This was usually in the classroom of the school where the interviewee practiced physics teaching. The names used in the following individual interview transcripts are not the real names of the participants.

The transcriptions of the four individual interviews follow. At the conclusion of all the interview transcriptions, summaries will be provided in which any evidence, or lack of evidence, will be cited for each of the five categories previously discussed. That is: Products, Physical Resources, Ideas/Concepts, Skills, and Attitude. Figure 1 provides a listing of the questions for Individual UPDATE Interviews. Thee questions are intended as areas of discussion and not necessarily asked in order, or answered as yes or no answers).

Individual Interview #1: Helen

Researcher	How many years have you been in UPDATE ?
Helen	Three
Researcher	Why did you decide to do UPDATE to begin with?
Helen	The most obvious reason was that I was getting certified in physics, and this provided a lot of credits, and it wasn't Mickey Mouse credits, it was valuable credits so I could do two things at once, I could get the knowledge from the physics and I would be among physicists make my background stronger and also get the credits so that I could get the certification, which I did.
Researcher	So after the first year you decided to go back the second year. And then the Third year, was that beyond the credits?

Questions for Individual UPDATE Interviews

1. How many years have you participated in the UPDATE program?

2. Why did you decide to participate in the program?

3. Did you rethink the topics you cover (your physics curriculum) as a result of participation in UPDATE ? Please give specific examples.

4. Have you changed the way you teach physics since UPDATE? For example. has the percent of time you spend in the lab changed?

5. Are there other changes in your physics teaching? Please give specific examples.

6. Do you think UPDATE promoted a particular teaching style? (Like a lab oriented, hands on approach?

7. In what ways do you think UPDATE promoted that style?

8. What effect do you think your participation in UPDATE has had on your students?

9. If I were to ask your students to show me work they have produced using UPDATE related ideas, concepts or materials, what would they show me?

10. What materials do you use in your physics classes that are from UPDATE? (for example a teaching unit or a multimeter) Would you have used these if you had not participated in UPDATE?

11. What teaching unit or units have you used from UPDATE? Have you used bits and pieces in other activities? If so how? (single focused units or related activities?)

12. Where did the units come from that you use?

13. What skills have you used in your teaching that can be attributed to your participation in UPDATE? (example: breadboarding) How often. and in what activities?

14. Have there been any spin-offs from UPDATE ? for example. have their been other activities or student products that have arisen from UPDATE activities or ideas?

15. How have you used UPDATE ideas or concepts in your physics teaching?

16. Can you cite specific examples?

17. Has your attitude changed in any way? Either towards teaching physics. physics or in any other way? Do you think your students' attitude has changed in any way?

18. Specifically, what aspects of the UPDATE program helped you to enhance your physics teaching or physics course?

19. I would like to list several aspects of the UPDATE program. Please tell me the extent to which each has had an impact on your physics instruction or course. and in what way.
    List
    a. Labs
    b. Lectures
    c. Resource Center
    d. Networking with other physics teachers
    e. Networking with UPDATE staff
    f. Teacher Demonstrations
    g. Field Trips

20. Is there anything else you would like to add or discuss?

Figure 1. Questions for Individual UPDate Interviews

Helen — Yes, Yes. Well the credits was the primary reason for the first year and half of the second. year. But, the fact is there are other things I could have done. I could have gone to other programs and gotten credit that way, but this was a top notch program, so I was going to get the maximum benefit out of my time.

Researcher — So why did you think it was top notch ?

Helen — Because it wasn't- I've done so many different things- we weren't studying the history of physics we were studying real physics, we were studying contemporary physics. When you are studying the contemporary physics a lot of that physics is chemistry. That's my major certification. So I was getting a better background for the physical chemistry. There were things like that. The labs were college labs. It wasn't more high school stuff. They were certainly for high school level, but everything was a notch up, which everybody wanted. It was one notch up from what were have been doing so when you brought it back you could be better at what you were doing. We weren't doing middle school stuff, we were doing college work with college equipment. A lot of equipment we were never exposed to. Which was a handicap for me, since I hadn't majored in physics. It was my minor, so all that stuff I had used but I had been busy doing chemistry and therefore didn't pay enough attention. And this was all that stuff, with one more chance with it.

Researcher — Did participation in the UPDATE program make you rethink what you taught in physics?

Helen — Yes. It helped me fill in a lot of blanks where I was weak. I was able to now do all of the physics curriculum.

Researcher — Can you give me some specific examples?

Helen — Uh, Let me think if I can. Motion, circular motion. That's something I had to pick up on my own. I couldn't remember that from when I had done it in college. So when we were talking about torque, we were talking about the equations for that. I could do the regular kinematics equations for that, but once you went past normal acceleration and you were into circular motion this is something I was winging, and I was hoping I was right. And when you are teaching physics it's not unusual that you are the only physics teacher in the building.

Researcher: Are you the only one?

Helen: Where I was, I was the only physics teacher. I had no one to say "could you tell me how to use this table?" And make the little ball fall off and you measure the acceleration, the circular acceleration, the circular velocity. I just couldn't do this. The circular velocity. The terms were very vague to me and was always afraid that I would be using them improperly like I think I'm doing right now. I just was comfortable.

Researcher: Well, the UPDATE program covered a lot of topics which aren't generally covered in a lot of high school physics. For example, quantum physics, space physics, communication physics.

Helen: But this is what the kids want to hear about. And when you are doing a lot of normal physics, if you can interject about this communication physics, or fiber optics. The principles behind it, then you have a hook so the kids are going to pay attention. And that's very important. They ask questions about this stuff. And If you have to spend time during your normal year, researching it, you know you're not going to. It was really valuable. It gave you so much better, perspective on all of that contemporary physics.

Researcher: Do you think your breadth of knowledge of physics is greater?

Helen: Fabulous, yes. Much much better. And with the chemistry, I found that I was much stronger with uh, the electromagnetic because of the chemistry background that I had, there was a lot of things about atoms, about energy levels, about the quantum mechanics that I knew. Because I teach the honors and I teach the second year chemistry class, but, you never know it completely until you've seen it from a different perspective. And listening to the physicist speak about it from their perspective, made me think about it differently and then that made me get a much better total perspective on that concept. Instead of my tunnel vision coming from the chemist's point of view. That was very valuable, the quantum mechanics that is a big part of chem II AP chem, and from that point of view the phraseology that is many of the books is borrowed from long ago from a physics book and a hem book and they haven't married the two. And you say that some of it sounds very sensible and then all of a sudden, what is this? Now I know what it is. It came from a physics book.

Researcher — When you teach physics, do you normally have a set curriculum, something that is produced by the school, or you follow the book or something?

Helen — Yeah. Yes.

Researcher — Did you change any of that, or rearrange, add or subtract something because of UPDATE?

Helen — Yes I did. Like I said, I was able to uhm, I was able to go into some aspects more deeply, because of the UPDATE, where I was scared to try before.

Researcher — Like quantum?

Helen — Like the quantum, I could look at some of the labs that had to do with the electromagnetic spectrum. I could use that more efficiently. Because, the students I had, I had as chemistry students, so I couldn't repeat a chemistry lab for them. If I hadn't had them, then I could pull this lab in and I could sort of like cover my tracks, so I had to do something different. I could use the spectroscopes more effectively. I wasn't really good at that from the physics point of view to understand why they wanted to find wavelengths, why they wanted to . . . . We found Planck's constant. That I didn't do in chemistry. I was more interested in other things . . . for the chemist.

Researcher	So, you mentioned the quantum physics as something that you changed in your physics curriculum. Were doing that at all before?
Helen	I was skipping it.
Researcher	You were skipping it. But now you're doing it?
Helen	Yeah, and I thought a lot of the teachers were skipping it before.
Researcher	Are there other things that you added to the curriculum?
Helen	Uhm, like I was saying before I didn't review what we have done in UPDATE, but I can honestly say that I did add a lot of things.
Researcher	Did you have to displace things in order to do that? How did you fit the new stuff in?
Helen	I found that would I could do was speed up. I went through the other things more quickly because first of all, I was more comfortable that it was OK to do that. That I was on target with it better. Because I could do that, then the second half of the semester did have more time to introduce these other things, which were really good.
Researcher	You mentioned the quantum, for example. Do you think that was the most significant?
Helen	Yes! Do you know why? Because it's very hard to find any course, any graduate course that you can understand the teacher explain that and have it match what you are doing in your curriculum.
Researcher	Right. Do you think you have changed the way you teach physics? Not just what you teach, but how you do it?
Helen	Absolutely! And that is more because, interacting with other physics teachers you share a lot of information. They gave you hints, you gave them hints. You got to discuss what you were doing and that only made it better. So in the summer, when you were away from your ten months of teaching, you could be more reflective and talk about what you had done, then the helpful hints

came in. They either confirmed what you were doing was fine, or somebody always had some helpful and interesting that was a great little addition. And some people would say that they don't do something anymore because it's never worked for me, you could say, you know it hasn't for me either but I figured I had to have it. And you could just say that wasn't the best approach to take.

Researcher — Can you give me a specific example of how your teaching in general has changed? Like are you doing more laboratory work now than you were before?

Helen — Well I always did a lot of lab work, but uh, I think what has changed is anytime you just add experience on to experience you refine and you improve. So three solid years of this has made me really improve.

Researcher — And what you attribute that to? Was it the networking with other teacher you were working with?

Helen — That's one very important aspect. Yes, fine people. Everyone who signed up for this because you had to give so much time. Including the one week being residential, and the time during the year. They were serious. They all had the same goal. They wanted to learn, they wanted to improve. You are dealing with fine people to begin with. And that over a period of time just helps you to become better and better. And, we were challenged to do better. Challenged in a way. I've been challenged in a way with the impossible because the program was horrible. This program said what it was supposed to do, it challenged us but gave us the wherewithal to accept the challenge and be successful with it.

Researcher — You mentioned earlier that your breadth of knowledge had been expanded. Are there any other changes in your physics teaching that you can think of that have come as a result of UPDATE?

Helen — Yes. Well, something along with that . . . the why. In Lowell, as with your site, the college professors were our teachers which was very valuable for my teaching. Because, we had several throughout the three years, and each of them. I could picture what the students were like that I had sent to them as they sat there listening to these professors. And I could see there methodology of teaching and what their expectations were. And from talking with them at lunch. they cant change, even when we as teachers are sitting there, and you could see if you were doing a good job sending the kids out to be science majors. That was really valuable. You have to think how to prepare students to be able to listen to these professors, and you know where to go to fill in the gaps.

Researcher So it gave you some feedback on your own teaching.

Helen Yes, of what it is I'm supposed to do when I send this child off. They are not just supposed to know some formulas, they have to have some skills so they know exactly where to go to get the material so they can understand.

Researcher Do you have a better idea about that now?

Helen The only reason that I have an idea was that I was sitting there. Other than that, it was twenty years ago that I was sitting there. Or else I was in a graduate class that wasn't geared towards students that were in high school. This was geared to being a course to teach students that were in our high school. I could take any course that was just physics, you know for my improved knowledge and be just a regular student like at Salem State. This was for teachers.

Researcher So in that sense it was really valuable.

Helen Immensely.

Researcher How about your confidence in teaching physics? Has that changed since the UPDATE program?

Helen With the three years of this program, definitely. Three years of anything as intense as this would definitely do that.

Researcher	Do you think the program itself promoted a particular style of teaching?
Helen	No. I think it promoted the best of the best styles. But I don't think it tried to push us towards one.
Researcher	Like, for example, the hands on approach.
Helen	It definitely, definitely. We had so many labs. That was something else. We had, every day, uh two labs. Because we were there from eight to five. So we had our morning lecture, then we had our morning lab, then we had our break, then we had our afternoon lecture and then we had the lab that tied into the lecture. So there were two a day times ten days, that was twenty labs for one course. That means I had sixty labs that I would never have had.
Researcher	Do you think that the program was telling you as a teacher that you should do more labs in school?
Helen	Well, hopefully you're doing that. But I worked in a school where I did not have anyone to set some particular equipment up for me. David (Pullen) and his crew had his TAs work very hard to set up the best equipment available for us. The electronics component we had was something that I had never been exposed to. Uh, doing the electronics with he little boards. I had never had that. I had done that at Bates college for a physics workshop that lasted from like eight to seven at night. And we did a lot of it. But we would do it like one of the days. By the time the UPDATE electronics was done, I didn't have to take an electronics course. I could definitely say to the kids, if I teach physics here next year, that I'm going to buy some equipment so the kids can have the boards and we can do some activities. I wouldn't touch that by myself. But now can because they prepped me with the background knowledge and I am hands on familiar with it and I can spend the time valuably setting up a lab. Where before, it was like pot luck if my time was going to valuable time. I couldn't risk it before.

Researcher Since we are talking about that, so one of the skills that you have learned in UPDATE was breadboarding.

Helen Absolutely.

Researcher Were there other skills that you are bringing back to the classroom?

Helen Yes, the analysis of the quantitative data. The way they do that at U-Lowell is very interesting. The percent error. How they do graphical analysis. That was something I hadn't done in a long time in the physics end. So what I was doing uh, much more basic, now I can understand it totally and decide how far I want to take it. At least now I got it. They leave a lot out. You know in the ancillary materials, they go from one paragraph to another paragraph and whoa, where did they go? How did they get here? I find now I scan the material and I get it, I understand. Before it was like I had to read other books to try to bridge this. I don't do that anymore.

Researcher How about using laboratory equipment, is that something that you brought back with you too?

Helen Yes, Yes. I was in a private school where we had no laboratory equipment, We had no laboratory equipment. And, everything was a struggle trying to put laboratory equipment together. And, knowing that I was working towards certification, and being in a school where I had no access to money or people to help me in the classroom, made me extremely nervous. But if I switch schools and I am physics certified, what am I going to do when I've got to do these labs? Motion detectors? Analyzing motion using the motion detectors . . . I never had that opportunity before. I may have had it in a two hour workshop, but not in the depth we learned in UPDATE. I also found many people were in the same boat as me. Which made me happy. Not that they had my problems, but that I wasn't just a person who was just so backwards with this technology. There were many people from good schools that because of cost or something, only had one motion detector. Some people didn't have any at all.

Researcher	Or meters or Oscilloscopes?
Helen	Exactly. Yeah. If you don't what an oscilloscope is or didn't play with one to see what's going on, it's a scary thing to feel inadequate.
Researcher	So in that case, it sounds like the UPDATE program hit the target pretty well.
Helen	Absolutely. For everybody.
Researcher	What effect do you think your participation in the program had on your high school students here?
Helen	We did a lot each of the years. Especially when we went to Amherst with seeing the applications. We would go to companies to see what was going on and how their technology was being applied in industry. And, that helped me speak to the he kids about careers. Speak to them about why we wanted to do a lab, because it really is done out there. Tell them the examples and give them the stories that got them excited and let them think of extra credit projects, like say the fiber optics or look up about contemporary ideas. There is so much more, like lasers. We did so much. So I can give them a lot more than I could before.
Researcher	If I were to ask your students to show me work they have produced using UPDATE either materials or ideas, what do you think they would they show me?
Helen	Last year we used Brown & Lemay, which is supposed to be an AP chemistry book. I used it for my honors students at Lynnfield. We did a lot with the Heisenberg uncertainty principle, we did a lot with the quantum mechanics because that book has an awful lot of the mathematics that is used with the he quantum. It was very easy for me to understand the constants. It was very easy for me to apply the math because we used that in UPDATE. So when I work with the kids, the kids could do that work and you know what? I had a student who got an 800 on the chem SAT II. And I had twelve students who took that. With that book and the depth that it goes into, especially in that area, I didn't have a kid who was under

690 for the SAT II. Most of them were 770 or 780. And I know it was because I could, very quickly, have a handle on these harder things, because this is an AP book. Yet I have never taught AP and the chem II class had mostly been organic but now I can swath into the physical chemistry that type of book does. I could not have done that not have done that without having to stay up until one o'clock in the morning. That was one of the reasons that they hired me because I looked at the book and I said I could do it. So the kids were happy. There is clarity with my explanations. I could talk about that kind of thing.

Researcher — Are you using teaching units? When you were in your group in Lowell, you guys worked on teaching units. Are you using any of those now?

Helen — Definitely. There is a lot of good stuff. I have everything categorized at home. I have my UPDATE shelf. I know just where to go for what. And uhm, there were some things presented I'll never use, but there is plenty that was good. There was plenty that was good. There was some stuff that was just to esoteric for me to want to use. I know I can have my husband build some of the contraptions that people came up with, like for circular motion. And it was like wow, I would never have thought of that. But it's so simple and now I can utilize that.

Researcher — So, it gave you a lot of new ideas.

Helen — Uh huh. It certainly did.

Researcher — Have there been any spin-off products or "daughter" products from UPDATE, for example have there been any activities or student products that have arisen because of your participation in UPDATE?

Helen — The rocketry. The rocketry that we did, Mark Green from across the hall here participated in UPDATE this year and even though he teaches the physics, he and I made out joint project the rocketry with his honors physics students. And we did a really nice job, I really must say. And, the kids enjoyed it. It was all after school, extra, for them. But what we are going to do next year is were going to do an integrated unit where it will be part of his class and my chemistry students are going to study the solid state fuel as the chemistry contribution and his students are going to do the rocketry part. Then we are going to bled the two classes together and make it joint project.

Researcher	That sounds like a good idea.
Helen	We are really excited about it.
Researcher	How about your attitude towards teaching physics, has that changed at all because of UPDATE?
Helen	No. Anyone who went into this had a good attitude to start. Because it wasn't one of these little one week projects. This was a three week commitment in the summer, one which was residential. Everybody had to drive a long distance to get to Lowell. Very few were living in the Lowell area. Some people came from New Hampshire. And then you had to commit yourself through the year. It wouldn't be worth it just for the credits or just for a check. It was worth it because you wanted to do something of high quality. So, everybody already had a great attitude. What it did is that it made us more confident. Especially for those of us who were cross-over teachers, it gave us more confidence because we got the knowledge. But, everyone was extremely enthusiastic. We didn't ever goof off. People never talked about The Red Sox. You know if they had a good game, fine but I've been places where you go to an all day seminar or all day workshop and no one talks about what's going on in the workshop. It's so sad and you get so mad because your time is so important. Every time we went there it was a full agenda and we all kept to it. So we already had the attitude. We were already little academic athletes.
Researcher	I'd like to read you a list of some of the aspects of the UPDATE program, and I would like you to comment on the extent to which each had an impact on your instruction. Not really how much you enjoyed the aspect, but if you really thought it helped how you do your job. The first one is the labs. These

are the labs you would get in the first two weeks at Lowell.

Helen — As I said before, the labs were extremely well thought out. Uh, very fluid. the computer programs matched what you were doing so you weren't hung up on your data. There were plenty of computers for all of us to work with. We rotated the labs easily. We got a lot of hands on time. They matched the concepts we were dealing with in our lectures. We had to produce data. We had to analyze data. Dave Pullen is a master at analyzing data. He goes into detail much more than I ever have dreamed of, and that was a nice exposure for me.

Researcher — So have you used those labs yourself, here? Or do you intend to?

Helen — I intend to. Yes. And Mark also found many of them quite valuable.

Researcher — How about the lectures?

Helen — The lectures were very good. At our site we got a book that the lecturers had made before the course started so we could follow along and highlight and so I would have a permanent record of what we did. And then there were blank pages so I could write my own notes. The lectures were very good. The astrophysics was very interesting. That go into astronomy somewhat. It got into astrochemistry a little bit. It was a very tough topic.

Researcher — So, are those going to help you with what you are doing here? Or, do they just contribute to your overall breadth of knowledge?

Helen — It will be mostly ancillary material. But, I have a student who just wrote me a letter and she is an astrophysics major in college. And I know those are the kind of kids that need to hear us talking about these topics. I have one student who is in plastics. So that's what I do in chemistry. I need to have this background in physics and it's the contemporary physics that helps.

Researcher — How about the Resource Center?

Helen	I think the Resource Center was nice, but I didn't have a lot of use for it because by the time I was in the second and the third year, I was at Lynnfield as the honors chemistry teacher and now I'm here as the honors chemistry teacher. So, I didn't have a call for it. I know that in Salem, the teacher who is in the next town over, has used it. And has been happy with what he has taken like the motion detectors and things like that. And I will use it, hopefully.
Researcher	How about networking with other teachers?
Helen	That's helped me. That's helped a lot. Sometimes when we did the labs and I was the chemistry person, there's an awful lot that I could share with them that they were clueless about. And they helped me understand some things I had no clue about.
Researcher	How about networking with UPDATE staff?
Helen	They are always available. Uh, they send Christmas cards. They are extremely interested in our success with this program, and always expressed an interest in helping us.
Researcher	Do you use them?
Helen	Absolutely. You know, I'm part of the consortium. So in all of the meetings I'm up there and David and the crew run that.
Researcher	So you are part of an alliance?
Helen	Yes. Yes. And it's nice now because when you go to the alliance, if you get there at three o'clock and the speaker starts you were saying hi to people who you don't know who they are. Now, they are my friends. So you sit down and "what did you do with this and what did you do with that, did this work, did that work." Now we have stuff to talk about.
Researcher	How about the teacher demonstrations?
Helen	Oh Yeah. That was excellent. Uh, some people had such access to the technology department that they can make these things that are just phenomenal. And it was nice

to see what they could make. You could go to lunch for days and pick their brains and find out how to do it.

Researcher	How about the field trips?
Helen	We went through the nuclear reactor. That was very, very interesting. We went through plastics. They are big on plastics. Even though that was a little more chem, that was good. They had the solar car. We saw the solar car. Some of us drove it. That was something my students liked a lot. That I could talk about popular mechanics magazine and the solar cars and the solar panels. And we had a solar panel in our kit, so we did do some work with that.
Researcher	Are there any other aspects of the UPDATE program that you thought were particularly useful to you in your teaching? Besides the ones I mentioned.
Helen	The guest lecturers that we had at Amherst. It was very nice, that if something came up that I could mention the name and I could say that this is someone that I have met.
Researcher	Like Phil Morrison?
Helen	Yes. That I have shaken his hand. The astronauts. The kids are just hypnotized by saying you have spent a week with an astronaut.
Researcher	In your physics classes or in your future physics classes, what physical material would you be using from UPDATE?
Helen	Yes, all those magnets. We got the Kits that were really good. The superconductivity thing. Which, my first project was on buckyballs. I did an integrated project with the chemistry of buckyballs along with the superconductivity from the physics perspective. And the kids made the buckyballs, had to analyze the structure and had to come up with a use of it. So they first had to totally understand this, and then have the historical background. And they came up with encapsulating medicine in the buckyball and adjusting it and everything. But they loved the superconductivity part. That kit is

very nice. I did a project at the museum of science last fall. Another teacher and I made a workshop for physical science teachers in the area which ran for a day. So we had to work with he scientist, the people who were in the museum. They have a very nice superconductivity demo that they do, which is no better than what we do. And yet they are the museum of science. So my students liked that a lot. So that's something that I would never have bought.

Researcher — Besides what you were given at UPDATE like the Kits and the meter and so forth, would you not have had that otherwise? Would you have any of those normally in your classroom?

Helen — I wouldn't have. I noticed that many of the teachers that have better equipment than I, liked that because they have a lot of junky stuff too. Now they have something that's really good. It's one more thing that doesn't have to go into the budget, because everybody's budgets are cut. It was like a grab bag. You would think it was Christmas. They were really happy to get the stuff. I didn't see anybody who thought, oh it was just a voltmeter.

Researcher — So, when you use that, do you use it with specifically UPDATE related activities, or do you now use that generally across the board?

Helen — Well, we're doing an electrochemistry lab next week, so I'll be using it.

Researcher — So you are using the UPDATE materials for a bigger part of your curriculum?

Helen — Absolutely. yeah. Definitely. Definitely, and with the electrochemistry, it's an interesting thing. I have the chemists perspective and I have stayed in the same mode. Now, I think of the broad spectrum and not tunnelvision and I think I make it much more fun.

Researcher — It sounds like the students enjoy it.

Helen — I think they do. Because I have a lot more fun. And I didn't know I wasn't. That's the crazy part. You don't know, because you don't get outside of this wall. And you go outside of these walls and someone says, oh, I just did this, I just did that. And, not working electricity much was an interesting thing. My father is an electrical engineer. I was always like his son that he never had. So, I was always doing stuff. But now, if the physical science teacher is doing stuff down there, I'll pull out the electrical stuff he has and bring it up here and say here are some pencils. That will work. Connect them to the battery charger, Let's go for it. I'm starting to think more spontaneously and things come to mind faster now.

Researcher So you are able to be more creative with what you are doing in class?

Helen Yeah, I really think so. I do. It's hard to tell exactly because every year you get better. But, I don't think It would be the same way.

Researcher Just to summarize, we were talking about how your instruction has changed. Can you describe, in summary, the most important changes that you and your instruction have undergone because of UPDATE?

Helen Uh huh. I think that every time now I read something and every time I think about a lab, I have a much broader picture of what it could do for the kids. What it could do for expanding our knowledge. Uh, I can look and the harder material. I can look at anything on electricity now. You don't find a course in electricity, like one of the things that you have to do to be certified in physics is you are supposed to find something on sound, on light and on electricity. You don't go into a graduate school and find an electricity course it can have a lot of electricity but it's not called electricity it not called sound, it not called light all those things make you a master of the trade to be called physics certified teacher. And they're all part of UPDATE as that all helped me get my certification faster. But they did accept components that UPDATE provided where they were saying I didn't have all of the gaps filled in, because they wanted a course on sound. You don't find that. You don't find the physics of sound but we did a lot that I could show them what we had done and they said "check it off, check it off." But, I can now take any alligator clips; I can take any wiring and I can just now think about, I'm used to ions moving in solution. I'm not used to thinking too much about where on an external circuit the electrons are going. What's the positive what's the negative, what the anode, what the cathode. But now I can just be thinking about that in terms of the physics of it and like I say graphite pencils, like we have an electrochemical chemical cell. That is definitely the type of thing that you do and you can just modify labs or I can go to the write up of the synthesis answers. I can go into the physics lab and look at the more difficult questions and instead of whiting them out, I can get the kids to get the answers now because I understand what the answers are. Now I can do that.

Researcher So that must give you a lot of confidence?

Helen It's wonderful. It makes me happy.

Researcher It also sounds as though it's been a big bonus to your chemistry teaching.

Helen Yes it has, yes. If we do electric potentials and voltage changes in the electric chemistry unit that I have my chemist's hat on and understood what I needed to get out of it. Now I understand much better the physics point of view of electrons moving through wires and what's going on here and there, and a voltmeter pegging, and things like this. Now I let them do it and find out the needles not going, think about it kids. And then they can play with it and I know that the voltmeter won't get wrecked.

Researcher Is there anything else that you would like to add before we finish?

Helen Well, I hope the teachers who organized this, the college professors, get their due credit. That the powers to be do understand how much time was involved in this program. Because sometimes when things are successful, which I think people would acknowledge that this was, It seems that it would have been no matter who did it. And, obviously, it could have been a disaster. It could have been well intended disaster. But I think it was a big success because these people worked so very hard. I'm sure they need a year rest. So I hope that they get that acknowledgment.

Individual Interview #2: Richard

Researcher	How many years have you participated in UPDATE?
Richard	Three
Researcher	And, why did you decide to participate, particularly for three years ?
Richard	Well, I had heard about it. You know I had heard about it. I had gotten a flyer or something, one of the early mailings. But what really convinced me to try it was, Uh, I was attending a loose association of south shore physics teachers, south of Boston, that Dennis Zicko sort of posted. He knew about the program and knew what it was going to be about, do that convinced me to try it.
Researcher	Is there already an alliance in your part of the State ?
Richard	Well, we haven't actually met in a while. But it's a very loose alliance, with different people attending at different times. It's really informal. But it's really good to have because, chances are, you are the only physics teacher in a school. Or, if there is another one, you may not communicate well. And, it's good to get together. Frankly, that was one of the big benefits of UPDATE.
Researcher	Are you the only physics teacher in your school?
Richard	No, there is one other. He participated in UPDATE for one year. But I was working on a plus thirty. So I ended up getting eighteen graduate credits out of it, which was great for me.

Researcher	Did you rethink the topics you cover in your physics curriculum as a result of participating in UPDATE?
Richard	Yes, certainly. Now there are some topics that I have dealt with minimally. For example, astronomy really doesn't fit into our curriculum. But am able to deal with it on the periphery, kind of. Uh, and I don't really go into quantum that much. But then again, I'm glad to know more about it. I'm glad to know what I don't know.
Researcher	Can you give me some specific example of what you have changed in your course?
Richard	Well, I do a lot more with electronics. A lot more. I really never did anything before, but as a result of the work with breadboards and things like that I can do a lot more than before, and it's nice to work in lab activities with that stuff.
Researcher	Right, um, some of the topics might be considered outside of what is normally covered in high schools.
Richard	Yeah. For example, I think trying to integrate communications into a standard physics curriculum, well, I haven't quite figured out how to do it yet. It's a really terrific idea, you know, taking the idea of encoding messages and the various electronic ways you can do that, and letting people know what the future is for communications coming into their homes. For example, the fiber optic cables or even the coax cables from your cable TV. I think we've just touched the surface in that capacity. And knowing the fundamentals of electronic communication, I think it's a good idea there.
Researcher	So what do you do in electronics that you didn't do before?
Richard	Well, I do more with fundamental electricity. You know, from Ohm's Law up. And a little more with communication and solar cells, modulating signals, and I make that little uh, transmitter with a flashlight and a solar cell like I saw demonstrated.

Researcher	That was from the third week?
Richard	I saw that particular demonstration down at Amherst I think.
Researcher	Do you think you have changed the way you teach physics?
Richard	Well, it's hard to say. It's hard for me to separate what was part of the UPDATE program and what was part of the interchange among the people in the coarse, frankly. You know, there was a lot of opportunity to discuss things with your classmates, as it were. I can't really say if it's the UPDATE program per se or just taking to people that resulted in the changes.
Researcher	So, what's different now?
Richard	It's hard for me to put my finger on it. I think I'm just able to deal with a much greater variety of topics and a wider variety of questions that come up than I could before. But it's very hard to give you specifics.
Researcher	So you are saying you feel more confident?
Richard	Absolutely!
Researcher	It also sounds like your breadth of knowledge is greater?
Richard	I know a heck of a lot more. Now I really do space physics as a unit. But, it's certainly something I'm conversant in now. Questions about that come up all the time. Like if there is a shuttle launch or something, at least you can say something. And, you can say something first hand about the people who went up there. I think the astronauts who spoke to us were fascinating.
Researcher	How about the amount of time your spend in lab? Do you think that has changed?
Richard	Yuh. I think it's more. You know, I know it's more. I have a good classroom set up for it thought, you know. I have a combination classroom/lab set up. One end of the room is lab tables and I can just move over to them. I can have little things set up. I can have demos and combination

demo/labs, and things like that with toys and hardware collected from UPDATE that are great to work with. Even the multimeters that I got are out all the time.

Researcher Are those things, like the multimeter, things you wouldn't have had otherwise?

Richard Yeah. Well, you know, since I was a relative rookie with electronics, I wouldn't of thought to have breadboards and multimeters out.

Researcher If you could characterize the percent of time that you spend in the lab that is more than you spent before, would it be like ten percent, twenty percent, or something else?

Richard Probably twenty percent more, But that's a real reach. I really couldn't put a number on it.

Researcher That's OK, it's just an opinion. Have there been any other changes in your physics teaching?

Richard I don't know. This experience, and the time around fifteen years ago when I got a masters degree, have made me appreciate my administration more, I'll tell you that. You learn the kinds of things other people put up with and deal with and go without. I'm appreciative of the system that I'm in. But that has nothing to do with UPDATE, it's just the opportunity to interact.

Researcher Do you think that UPDATE promoted a particular teaching style? For example, a lab on hands-on approach.

Richard Yeah, it certainly promoted that because it was like fifty percent lab time. But I think it's also hard to distinguish between what UPDATE was promoting and what naturally occurred due to the mix of people who were there.

Researcher What do you think your participation in UPDATE had on your own students?

Richard Well, I think they had access to a lot more information. I spent almost twenty years in the junior high and only the last six or eight years teaching physics.

Researcher	Were you first trained as a physics teacher?
Richard	No. I spent most of my time, well, my undergraduate degree was actually in political science with kind of a minor in natural science. When I first started teaching, because I had so much science they wanted me to teach eighth grade IPS. That was a wonderful course. Unfortunately, it takes a kid with a little horsepower to do it. I spent a long time teaching that course before I moved to the high school. My graduate degree is in physics.
Researcher	If I were to ask your students to show me work that they have produced using UPDATE related ideas, concepts or materials, what do you think they would show me?
Richard	Ah, I don't know other than the stuff dealing with electronics. As I say, most of the information, well, I made a methanol cannon which I demonstrate to them and use Newton's Laws and trajectory and that kind of stuff which was a result of UPDATE. I made a Geiger counter that was part of the energy unit. That was part of our unit in nuclear energy. And I made an air rocket.
Researcher	It sounds as if you got as much out of the interaction with other people than you did out of the regularly scheduled labs.
Richard	Yup. Yup. I would say. For example, I did not get a great deal out of the thermal lectures the first year. The level was too high for me. The lecturer, I don't think, realized who he was talking to, to some degree. And it wasn't something we could bring back to the classroom. Whereas the lab stuff was. The stuff with liquid nitrogen, electronics stuff, thermocouple and a lot of that sort of stuff we could use.
Researcher	You mentioned the multimeter. What other materials are you using in your classes that are from UPDATE?
Richard	Well, I certainly use the magnets all of the time. In fact, I just ordered a bunch of the Project Star spectroscopes, which are terrific. They're right on the money. Compared to the ones we used to use in IPS

	and still use in physics which are, you know, a toy. You know, I have such a pile of junk. It's hard for me to tell what I've picked up from UPDATE. I just sort of pull stuff out when the time comes.
Researcher	Is there anything you wouldn't have had or would not be using if it wasn't given to you at UPDATE?
Richard	Well, as I've said, the biggest thing is the electronics. And I, uh, still have a long ways to go there. I should incorporate more, frankly. Because, as I say, if you can incorporate the basic ideas of electronics with the knowledge of the ideas of communication and the encoding of information and so forth, it's pretty valuable information that most people have no clue about.
Researcher	Are you using units from UPDATE?
Richard	No. We have a defined curriculum that you pretty much have to stick to.
Researcher	But you squeeze in UPDATE stuff?
Richard	Yeah. Yeah.
Researcher	So, what have you changed? Have you thrown anything out and put something else in its place?
Richard	Well, I always do that. But again, uh, I couldn't tell you exactly what I do because I don't quite do the same thing year to year. I'm not monitored to that extent. Uh, I'm the only one who teaches physics at my level, so I don't have to keep up with someone else or give standard exams and so forth.
Researcher	Have you seen the units that other people have come up with?
Richard	We really haven't, from other schools. Uhm, John talked about it at our last meeting, about getting everything together and presenting it, deciding what format to give it and so forth. You know our stuff is in separate spiral bound units which we have. But we haven't looked at other stuff from other schools. We had access to it I guess.

But, I have so much stuff, that I don't know what to do with it.

Researcher So you use the stuff you produced at Dartmouth?

Richard Yup. Yup.

Researcher Could you tell me specifically what you used from those units?

Richard We have access to liquid nitrogen through them. Although it's a long trip for me, I can get it and I have on occasion. Some people have spoken highly of a liquid nitrogen demonstration unit that was produced by a group from Dartmouth the first year. That's particularly good. Like I say, it's kind of a trek for me to get down there. I'm kind of hoping to find a closer outlet for liquid nitrogen.

Researcher Thinking about the skills that you use in your teaching that can be attributed to UPDATE, like breadboarding, for example. Have you used a breadboard before?

Richard Nope. Never even heard of one. But I'm damn good at it. Well, I think that electronics and electricity in circuits is a special kind of intelligence. Some people have it and some people don't. Uh, and when you do it with kids, there are some kids that can look at a schematic and look at a circuit and see the connection, and some kids just can't. I do some of that with ninth grade kids in an introductory science course and you can tell the ones with whom it has clicked, and those that haven't. They look at those wires and they don't see any connection between what they have' drawn and what they have in front of them. So I do a lot more with wires than I did.

Researcher And the kids seem to enjoy it?

Richard Oh, Yeah. Yeah. In fact I have done, making a motor, you know which is pretty common activity. Uh, but when kids catch on and can make a motor and can really see the principles that make it work, it's a wonderful activity.

Researcher Have there been any spin-offs, like daughter products, from UPDATE? For example, have there been any activities or student products that have arisen from UPDATE ideas or materials?

Richard I can't say specifically because I'm teaching a freshman physical science course that I haven't taught for five years or so. And I've done some different projects with them in the past, but they are not particularly UPDATE related. No I really can't say that I have.

Researcher How about personally? Has your attitude towards teaching physics changed since your participation in UPDATE?

Richard Well, I think I have a hard time dealing with it myself. Uh, in the topics in quantum, for example, I realize how little I know and what my chances are of ever knowing anything. And I sometimes have a hard time coming to terms with that. But at the same time, I'm fairly successful, so I sort of have to put that aside.

Researcher How about your students' attitudes? Have you seen any change in their attitude because of your participation in UPDATE?

Richard Well, unfortunately, it's not in too many kids though. Unfortunately, the majority of the kids still aren't very interested in what they're doing. And those that do well, it's because they have a goal like getting into a particular college rather that attaining some knowledge. I think that's one of the sad things that we have to deal with.

Researcher So, among those students who are really interested?

Richard I think it's great to give them a hands on opportunity, because one of the things that we don't test very often and schools don't test in general, it gives those kids who have an aptitude and a knack for those things that don't usually show up on paper, to shine.

Researcher — Well do you think those students who are interested in learning are more interested because of your participation in UPDATE?

Richard — Yes, I would say so. Certainly, some of the demos, which are really exciting, are real attention getters.

Researcher — With you being more confident, it probably adds into that?

Richard — Yup. I do want to mention one thing. I can't really remember where it came up, but it's a nice mix with math. One of the lab assistance made up, there were coffee cans that were weighted with lead and rolled down a ramp. The lead was flashing, like around chimneys. And one of the coffee cans, the lead was around the periphery of the can, on the inside, on the circumference of the can. The other was on the inside, in the middle of the can. The cans had the same mass, but very different rotational inertia. And if you rolled those things down a ramp they accelerate at different rates, and one passes the other. But when you do that with a motion detector and look at the graph, neither one looks like a classic acceleration graph. Whereas if you run a cart down the ramp with low mass wheels you get what you would expect to get. The calculus people like to look at those things and have the kids figure out what the graphs are shaped that way. They don't really fit the nice clean formula that they like to see. And that's something that certainly came from UPDATE and mixes nicely with math and science.

Researcher — Then do you do more things with math?

Richard — Yeah. But part of that is that we have an outstanding guy at our school with graphing calculators. It's very interesting. I've helped him with demos and things.

Researcher — I'd like to list some aspects of the UPDATE program and I would like you to tell me the extent to which each has had an impact on your physics instruction, and in what way, if you could tell me that.

I'll start out with the labs. These are the labs that would take place during the first two weeks of the program.

Richard — They certainly were valuable and have had an impact. I mean, I don't really know what I can say.

Researcher — Well, you have actually discussed some of that before. How about the lectures?

Richard — I found the lectures in certain topics particularly interesting, and some, incomprehensible. Some interesting but not particularly useful, and some very useful. You know they run the whole gambit.

Researcher — So do you think they have helped your instruction?

Richard — Sure. Sure. It gave me more background.

Researcher — OK. How about the Resource Center?

Richard — I'm not a very good one to a ask about that because I'm so far from Dartmouth. I know, from when we meet, that other people are using it much more that I am able to.

Researcher — How about networking with other physics teachers?

Richard — I do more than I did before. But again, because of my proximity, not as much as other people are doing. I mean, I can tell just from the conversations that other people are doing a lot more with it than I am.

Researcher — You also said earlier that talking with other physics teachers was something that really helped your instruction.

Richard — Absolutely.

Researcher — How about dealing with UPDATE staff? Have they helped your instruction?

Richard — Yeah. I mean they are terrific in terms of being accommodating and willing to do things. I thought they have been terrific.

Researcher — Would you characterize your change in instruction the same way?

Richard	Sure.
Researcher	Teacher demonstrations?
Richard	Well, I do a lot more than I did. I mean a greater variety of things. And they are catchy things, and that's important.
Researcher	How about the field trips? Have they helped your instruction in any way?
Richard	Yeah. Particularly the one to Northfield in the power project. Because I do a lot with energy and I'm particularly interested in being a cheapskate and energy conservation. And knowing something about power production and how we waste it and so on. That was particularly fascinating to me.
Researcher	Are there any other aspects of the program that you would list as having had an impact or being really important to your instruction?
Richard	I think we've covered a lot.
Researcher	OK. So overall, just to sum up, how would you describe how the program has affected your instruction?
Richard	Well, it had a very positive effect on my instruction. I can't think of any negatives, certainly. Uh, it's had some sort of sobering effects on me but I sort of knew that anyway. You know, in terms of knowing my limits. Uh, and it just worked out well for me because I was working on a plus thirty anyway, so it was a great opportunity for me. And I enjoyed going out to U-Mass a lot. As a result, my son is going out there now. I was impressed with the place and impressed with the price.
Researcher	Then overall, you are doing more laboratory stuff, and you are doing more electronics stuff. You said you were more confident and your breadth of knowledge was greater.
Richard	Yup. Yup.
Researcher	Those were the main things we talked about. Are there any other things you can think of?
Richard	No, I don't think so.

Individual Interview #3: Cheryl

Researcher	How many years have you participated in UPDATE?
Cheryl	Two years.
Researcher	That was the previous two years?
Cheryl	Yes, the last two years.
Researcher	And why did you decide to do that ?
Cheryl	I teach physics and I really don't have a physics background. I just fell into teaching physics and I wanted to get my background stronger so I'd be better prepared to teach. And I was looking for more labs and hands on things to do with the kids in class too.
Researcher	But then you came back for another year. Did you come back for the same reasons?
Cheryl	It's a good program. It's nice to be able to network with the people at U-Mass and the people in the area who are in the program. It's very supportive and I just got a lot of stuff out of it in a lot of different ways.
Researcher	Did you rethink the topics you cover in your physics curriculum because of your participation in UPDATE?
Cheryl	A little bit. I did more of the nuclear chemistry stuff due to the modern chemistry that we did. I also did more in physics. I did a whole section on nuclear reactions and stuff like that that I had never done before. And, brought in a lot of stuff with the structure of the atom and things of that nature, because I thought it would be useful to the students because I teach a general level physics, for the last couple years. I taught the structure of the atoms, how nuclear reactions worked and what radiation is, and things like that which are really helpful to them.
Researcher	So you took that from the quantum physics that we had last year in UPDATE?
Cheryl	Right.

Researcher	Does that mean that you are adding things or displacing something? How are you working that?
Cheryl	I added in the nuclear stuff in the physics curriculum. I supplemented what I was already doing with atomic structure in my chemistry curriculum because that fit in really nicely with the stuff Roy did last year. So, I didn't leave anything out of chemistry, but I did add things in. More details in a couple of activities, some of the stuff that I developed for the program I used and tested out in those classes. In physics, it's hard to say if I left anything out because we changed physics books. We went in to the conceptual physics for the general level, and I hadn't used that book before so that was kind of new and we were just playing around and seeing what we wanted to do. I probably didn't do as much mechanics, but for that level I think that was OK because I was looking at that general level as things they might actually take out and use. Things that they could use for maybe job skill or even just voting and things like that.
Researcher	Your school does offer and advanced level? Do you teach it?
Cheryl	Sometimes I teach the college prep level. But I haven't taught the AP level. Pat Carey usually does that.
Researcher	Do you think you have changed the way you teach physics?
Cheryl	I think that I'm moving more towards more hands-on things and kind of small project sort of things. Part of that is because of UPDATE because I feel more comfortable with equipment and things like that, ideas for experiments and projects. Part of it is just the general trend in Ed reform and stuff. Both of those things kind of mesh and are changing those things a bit.
Researcher	So you are spending more time in the laboratory?
Cheryl	Right. Trying to. I think especially like when I teach the general level or the lower level. If you can do something concrete

that they can touch and put together and see how it works, their understanding of it, or their excitement for it seems to be a lot better than if you just kind of talk about it conceptually and, you know, just talk back and forth about what do you think will happen or why you think this will happen. It's better when you can attach it with something with something for them, particularly.

Researcher — Do you think there has been any other changes in your physics teaching due to your participation in UPDATE?

Cheryl — I think for me, I have a better background so I'm better prepared to answer off the cuff questions than I was before. Or, if I get a question that I don't necessarily know the answer to, at least I have more resources. Like, oh, I remember that, or I remember seeing something about that, or I have places to go to look that up.

Researcher — How about your level of confidence?

Cheryl — Much better. Much better. Definitely. And again, I'm probably one of the people who have had maybe the weakest background because my undergraduate, all I had was general physics and that's when I first started teaching physics, was just from my general physics from college. And then when I took my masters at Worcester Poly Tech, I had some mechanics, some E & M, and some modern physics, so that was a little better. But the UPDATE program and actually the institutes that they had years before really helped to fill in a lot of the gaps that I had.

Researcher — Did you do the original institutes at U-Mass years ago?

Cheryl — Well, I did two of those institutes.

Researcher — You were talking about doing more in the laboratory. Do you think that UPDATE promoted a particular teaching style?

Cheryl — I think as far as the stuff we produced, that was definitely promoting more laboratory work. Because everybody was doing some sort of project that the students would do in the lab. So, that part, definitely promoted doing more hands-on laboratory work. I think the instruction for us, it was pretty much the same as usual, we got our lecture, we got our lab and I think for our level that was fine. We needed the lecture and then we went into the lab and played with some stuff. And, going up to the lab was helpful because, although some of the equipment we used, we will never have at the high school level, it made us familiar with it, it gave us an idea of how that worked. I think a lot of people took some of those ideas and tried to adapt them to what we have to work with at the high school level. I think those will be really helpful when all the different packets come out.

Researcher — Have you done that also? Have you tried to adapt some of that stuff that you had done in lab to your own teaching?

Cheryl — Uhm, a little bit. I have to admit, I've just finished my CAGS, so on top of doing that I have been doing a lot of course work. So, I haven't done a whole lot of that, But I'm hoping next year particularly to target my general physics class to do a lot more hands-on, more activities. As we move into block scheduling, we are not doing it next year but were supposed to do it the following year, I know I'm going to need a lot more than that, for that level in particular. Because and hour and a half in the classroom, those kids can only sustain fifteen or maybe twenty minutes of any particularly activity.

Researcher — What effect do you think your participation in UPDATE had on your students?

Cheryl — Uh, I think for one thing, that when students knew I was in that program, that kind of gave them a little more respect for me. They thought, oh she was at U-Mass and they were doing this and that, and oh she was doing this with Mr. Carey and he teaches the AP and she's still in that program with him. So in that way, it increased respect. And also just to be able to say, we did this experiment and this is what it was like, or I was talking with this person and I learned this about this. I think it makes them see that we are still broadening our background and learning more. It makes us seem more knowledgeable in the field.

Researcher: Do you think you are looked upon differently because you teach the standard level courses instead of the AP physics ?

Cheryl: No. See, I teach college prep chemistry too. They also know I teach [a] course at night at GCC. So I think they don't think anything like that. I could teach an AP level now if wanted to. Right now I don't choose to. But at our school the science department teaches an overload of contact hours because of labs and there are only so many ways you can fit those schedules. Like I teach 24 contact hours which is the maximum that you can teach and I don't' even have an AP course.

Researcher: If I were to ask your students to show me work they have produced using UPDATE related ideas of materials, what do you think they would show me?

Cheryl: In my general physics class we did a section about treating the electron as a wave as opposed to a particle. And in lab we made this model showing, we picked a piece of paper to be a certain wavelength and then they made the energy levels, the second energy level would be twice as long, the third would be three times as long and we made rings and put them on paper. We showed where the different energy levels were and areas where they wouldn't find the electron. We talked about why that wouldn't happen. We talked about the electron being a wave and things like that. I think that worked pretty well. And that was a concept that was really hard for the kids. They can kind of picture the electron as being a particle with no problem, but where does this wave idea fit in? So we did that, and it worked out really well. And my chemistry kids, and this just happened to fit really well with my chemistry. We did some work with probability. We talked about probability and finding the electron in certain places outside of the nucleus. Then they came up with some games using probability and they related that to finding the electron and the probability of finding it here or there.

Researcher	So you're finding a lot of overlap between your chemistry and physics teaching?
Cheryl	Particularly for the quantum stuff. And for the year before the energy stuff there was a certain amount of overlap. It's nice for me because I do teach both, I was able to use it in both places.
Researcher	So, the UPDATE program has helped your teaching in general, both in physics and chemistry?
Cheryl	Right.
Researcher	What teaching units are you using or have you used from UPDATE? Or, are you using bits and pieces, or both?
Cheryl	I'm using bits and pieces, I think. I have used things, as I've mentioned, from the quantum. I have used quite a bit of that. I used a little bit about space. I don't do a lot of astronomy or space physics, but the kids always have questions about black holes and this and that, space travel. Those come up from time to time and we do discuss it. I definitely use the energy stuff in both the physics and the chemistry, and a little bit about communication now and again when ideas come up, but not as much as the others.
Researcher	Then you are using them as units then?
Cheryl	Right. When we're studying different units, I bring those ideas in.
Researcher	Are those units some of the ones you developed?
Cheryl	Right. Yes.
Researcher	How about other people's units? Have you had a chance to use any of those?
Cheryl	Uh, no. Not yet. Well, actually we do kind of get copies of everybody's, but we only have one book so far from the first year. I'm hoping when the other books come through that I will be able to pick and choose things from that.

Researcher	Are there any skills that you use in your teaching, particularly physics, that have come from UPDATE? For example, breadboarding.
Cheryl	Well, I will say that I am much more comfortable doing the electrical circuits and stuff from doing that, because that was an area that I was really weak in. And having done all of that with the communications with Monroe, I felt much more comfortable reading those diagrams and troubleshooting when kids have little circuits made up. Oh yeah, that where your problem is. Or, look over here, that may be a problem. So that has helped a lot. Not necessarily doing those exact things, but using that particular skill.
Researcher	Do you use materials from UPDATE, like the Kits you received?
Cheryl	Oh, definitely. And I've actually lent them out to people in my department who are teaching physical science this year when they were doing different things. Oh Yeah, I have this little hand generator, all kinds of stuff like that. We have just instituted physical science for the ninth grade, and so one of the women who was teaching that would come in and say, "do you have any of this or that?" And I would say, oh yeah, and take out stuff from my kit.
Researcher	Do you use the material you received in your Kits on a regular basis?
Cheryl	Uh huh. When it comes up in the chapters, we take in out and use it.
Researcher	You use the hand generator, and multimeter?
Cheryl	We used the lasers this year. I went to a laser workshop last year and so I wanted to do laser work, but we only have one laser, so the little hand lasers we use. I have used mine. I have used Pat Carey's. So we're incorporating all that stuff I would say.
Researcher	Would you have that stuff in your school had it not been for UPDATE?

Cheryl	Some of it, no. I mean, we have some meters. WE don't have the nice multimeters like we got in UPDATE. Now, we have four in my school. Because I have two and Pat has two. We didn't have anything like that before. We just had the old meters you plugged into the circuit, you know. We didn't have anything like the multimeters. So, some of that stuff we didn't have at all, and some of it was just added to. Not a whole lot, like the lasers. Those pocket lasers were good for a couple little experiments, and that worked out nicely. That allowed me do a lab, not just a demonstration. I broke the class up into groups, a little bit large maybe. But at least they all got to mess around with the lasers a little bit.
Researcher	Are you able to add to that with your budget at school?
Cheryl	A little bit. I tried to add some. I tried to get some more lasers this year, but they cut half of my budget. But there are other things that we've added in. Between my budget and the people teaching physical science we got some more stuff.
Researcher	If I walked in your class, say, to observe one of your physics classes would I likely see some of the materials you got from UPDATE?
Cheryl	Definitely, yeah.
Researcher	Have there been any spin-offs or daughter products from UPDATE, like projects the kids have been doing or activities that are directly related to or have come from UPDATE ideas?
Cheryl	I don't think so yet. Then again, I've been busy with course work and I'm hoping to more of that next year. So, not really yet.
Researcher	OK. Do you think your attitude has changed in any way, particularly towards teaching physics?
Cheryl	Uh, I've always liked teaching physics, but I feel more comfortable. Now every time I get involved with any physics, I think I bring something back and I'm able to add a

	little bit to my background which makes my instruction better. So, I definitely think it helps.
Researcher	How about the attitude of your students? Are they aware that you have been in UPDATE? Do you think that has changed their attitude in any way?
Cheryl	I think it's made them more aware of different areas of physics that they may not have thought of before. And also I think, I have to say, it's made them very aware of UMass and how UMass gets involved with the people. It true, you know, I would say that I was up at UMass and you know, we did this and this, and they have this Resource Center and we're going to be able to borrow this equipment. So they see that this is a place that is involved in the high schools too. It's kind of taking the physics people up there out of this sort of ivory tower, they think of us. So, I think it makes them feel like it's an option or a place they might look into to go to school.
Researcher	Can you tell me specifically what aspects of the program helped you to enhance your physics teaching?
Cheryl	Uh, the instruction in the quantum physics definitely did. The work in energy helped. The labs in energy. The labs in the quantum physics were interesting to me liked them but that didn't directly relate to my teaching. I don't really have that kind of equipment. But then we were able to develop things from what we had at school to work with. So I think those were the two big areas for me.
Researcher	I would like to read you a list of several aspects of the UPDATE program and I would like you to tell me if they had an impact on your instruction and in what way, and extent, if possible. Please feel free to respond in any way you would like. The labs. Do you think they contributed to your instruction?
Cheryl	They were helpful in giving me a stronger background and understanding. For instance, we did the Milliken oil drop thing this

year, which I had never done before, but I always talk about it in both chemistry and physics. So I actually got to play around with that a little bit and it gave me some more experience. So It gave me a better background, but it didn't translate directly into my labs in that respect.

Researcher: So it helped to improve your instruction?

Cheryl: Right. Right.

Researcher: How about the lectures?

Cheryl: The lectures were really helpful for me. They enhanced my background and made things clearer so I could make things clearer for my students.

Researcher: The Resource Center?

Cheryl: I think when the Resource Center is up and running and everyone is looking forward to that, it's going to be good. It will just a matter of just going up and getting the stuff. Right now that's not part of what we do.

Researcher: Would you take advantage of that if it was available to you ?

Cheryl: Yeah, I think so. There's going to be a lot of good stuff up there.

Researcher: How about networking with other teachers?

Cheryl: I've definitely been doing that. I've met some people, for instance, Val. Val and I have become pretty good friends. We often touch base with each other and talk about things and that's been helpful. Also, I know there are other people in the area that are teaching physics that I can get in touch with too.

Researcher: And networking with UPDATE staff?

Cheryl: Yeah, I feel pretty comfortable about that.

Researcher: Have you talked with people or used them as a resource?

Cheryl: I talked to Carl a couple of times when I've been to different things up at U-Mass. I've talked with Roy. So, it just makes it so much more accessible. I know they are there and I know if I call or if I go up, it's not going to be a problem. They are pretty receptive.

Researcher How about teacher demonstrations?

Cheryl Those were fun. Those were helpful. A lot of those were easily translatable into the classroom. Some of them were really interesting.

Researcher The field trips?

Cheryl Uh, Let's see, where did I go? Northfield Mountain. Uh, it was interesting to me but I haven't used it in my classes at all. For us, we are so far away that I don't think that's something we would take our kids to. But If I were down her, that might be something that would translate easily into the classroom.

Researcher Is there any other aspect of the program that has been significant, or has made a contribution to your instruction that we have not talked about?

Cheryl No. I just think being there and being accepted as part of that group and feeling comfortable with all those people has been really helpful.

Researcher So, overall, how would you describe how your participation in UPDATE has affected your physics instruction. Just summarize it.

Cheryl I think that it enhanced my background so that I can talk more comfortably about different subjects. And, I think it's made me aware of more things to do in the lab and made me look toward doing more hands on work and more lab work with my students.

Individual Interview #4: Fred

Researcher	How many years have you participated in the UPDATE program?
Fred	All Three.
Researcher	All Three. And why decide to do that ?
Fred	Because I had no real opportunity to stay current with physics principles, with modern physics. Um, whenever there would be courses that would be offered that would update my physics knowledge, they would usually be offered during the school day when I was working, or I had other commitments. Most of the courses that are offered for a teacher's schedule are in pedagogy, in educational philosophy. They are not necessarily offered to support the knowledge base a teacher needs to maintain and develop. One of the problems that is very real is that many of the skills that I used to have when I was in college, when I was working on physics in an active fashion as a student, atrophied very quickly after a few years of teaching. In fact, I often find it by the end of the year difficult to even speak like an educated individual. I start talking like my students. (Laughter) If that affects my speech patterns, you can imagine what it did to my ability to work either mathematically or conceptually with some of the more sophisticated concepts and ideas in physics.
Researcher	Did you rethink the topics you cover in your physics curriculum as a result of UPDATE?
Fred	Yes.
Researcher	Can you give me some specific examples?
Fred	I'm trying to change the sequence. I'm going to start with some concepts in electricity and magnetism. One of the things that appeals to me, I just got a flyer in the mail today, let's see, a program at Kansas State University called Visual Quantum Mechanics. I wouldn't have had any interest in this if it hadn't been for the UPDATE program. Uh, they're field testing material to teach quantum mechanics, or to explore the quantum world. And they

say it's for non-science students. Hopefully, I'm going to try to take advantage of that.

Researcher At the high school level?

Fred Yes. It not only includes a computer based simulation, but hands-on activities. They say it emphasizes hands-on, minds-on activities. You know this is hype. I have their world wide web address which I can send to you if you are interested.

Researcher Yes, send it along. So in terms of rethinking the topics you cover in your physics curriculum, you are going to change the order a bit, starting with E&M?

Fred Uh, Yeah. Magnetism and something called a mag-lev vehicle. Uh, some of this was based on work done by the National Association of Highway Engineers. I'm using, not only to teach physics, but to teach students how to work in teams. The idea is to give them a task of building a device made out of Styrofoam and magnets that will hover and then move. So I'm teaching both mechanics along with magnetic levitation. The direction is to have the students self evaluate their work as a member of a team so they can understand what team behavior should be.

Researcher So you're leaning towards project work.

Fred Yes.

Researcher What about some other topics that UPDATE has offered? A lot of them aren't particularly well represented in most high school curriculums.

Fred Ah, no. In fact in some cases I've taken portions of them. Well, for instance, the space science led to with rockets made from soda bottles and that's become an early September activity where not aerodynamics would be discussed and worked upon, but there would be an opportunity to run something like a physics Olympics competition at the local campus U-Mass Boston. And we are working on a day in early October to bring students in and have a field day using these water rockets.

Usually we wait until field day activities late in the spring, but now we are stating earlier.

Researcher — So that's almost like a spin-off.

Fred — It's a spin-off more than a direct application. The students I work with, I refer to them a terminal physics students because this may be the only course they will ever take.

Researcher — Are they conceptual level or are they above that?

Fred — Right, at the conceptual level. Mathematics is side stepped. In many cases, those topics that I can cover without rigorous mathematical analysis are appropriate for this group. These are the guys who are going to become the politicians, the lawyers, and they're going to control purse strings for the type of research that may be funded.

Researcher — Can you give me some other specific examples of how your curriculum has changed because of UPDATE.

Fred — Well, let's see. Well, one of the areas is not so much the subjects that were taking in UPDATE, but the opportunity to network with teachers across the state and the region. That networking has continued and occasionally we've helped coordinate some cross fertilization of ideas. The other area of interest is that some of the material helped to support my understanding of the mechanics of satellite imagery. I'm endeavoring to set up a satellite receiving antenna on our roof. But the next level is image analysis. I was able to get out to Tucson Arizona and visit the center for image processing and education. They're developing new software that will work in our computer here at school. I also had the opportunity to visit some of the observatories out there and if it hadn't been for some of the astrophysics presentations, I would have been lost in understanding what I was seeing.

Researcher — So the UPDATE program sort of broadened your base a bit?

Fred: Oh Yeah. And the other thing is that I'm more comfortable talking about quantum mechanical effects and relativistic effects. Because now I have some connections between theory and application, and that is something I didn't' have before. In many cases it was just a mathematical, well it was not something that I would have considered of interest to my students. But that has changed.

Researcher: Have you also changed the way that you teach physics?

Fred: It's hard to say. The way I teach physics changes every year.

Researcher: Well, for example, has the percent of percent of time you spend in the lab changed because of UPDATE?

Fred: I try to have more projects or activities than I did before. But one of the limitations is a real one, and that's the limitation of facility and resources. The financial situation is very limited. I might have about five or six hundred dollars to spend every year. And, the most sophisticated computer I have is a Mac 512, which was built in 1985. And most of the computers I'm using are Apple IIEs or II Pluses.

Researcher: So, you're changing your teaching methods a bit by moving towards project work?

Fred: Yes. But the other point is that I'm willing to cover normally would have been relegated to the end year. I'm incorporating them into discussions early in the year.

Researcher: Like?

Fred: E&M, Light, Uh, I've played around with starting with a unit on optics. One of the things that became very clear to me, was that starting with the traditional sequence of stating with mechanics and moving to, in some cases the more interesting topics of waves and other phenomenon, may not be the appropriate way of handling it. I'm thinking of playing around with the sequence starting with waves and magnetism early in the year. In the hope of then, using it as a link to tie into the motion studies. One of the primary reasons is the problem of preconceptions. Students are so well developed with their conceptions of mechanics and the way things move that teaching topics like acceleration is very difficult. Whereas, if I could approach it from a topic that they were less familiar with. I might be able to grab not only their interest, but their willingness to understand that Uh, maybe they don't understand it all. High school students have a tendency to want to believe that they already know everything there is to know. And, anything that you present is just a rehash of things they already heard about. This becomes clear when I give an essay test or essay final, and they tell me things about what causes tides and why hot air rises, and it's very clear that they are using answers and responses that they may evolved on their own, independent of any instruction.

Researcher Is this true of your more advanced classes? Are you planning to do the same thing with them?

Fred I don't have more advanced classes.

Researcher So you teach strictly at the conceptual level?

Fred That, and I teach an engineering course.

Researcher Have there been any other changes in your physics teaching due to your participation in the UPDATE program?

Fred I'm trying to think. I'm sure there have been. Well, one of the most significant is that all the materials that I have received as part of Kits during the three years, have found their way into the students hands. Everything from the multimeters to the various demonstration devices, where the students are using them. That's one area. But, uh, I think its primary effect was the development of confidence in the subject matter and a fuller understanding of how the physical reality is tied together in light of new discoveries and research.

Researcher So that would lead you to more fully use that knowledge in your physics instruction that you wouldn't before?

Fred Yes. The other effect, I think, is that I'm reading more in the literature than I did before. I can understand some breaking theories in various areas of optics, quantum physics and astrophysics which I didn't even have a handle on in the past.

Researcher Let me ask you about the UPDATE program itself. Do you think that UPDATE promoted a particular teaching style? Like, for example, a hands-on or laboratory teaching approach?

Fred Well, not necessarily. A lot of the presentations were lecture based. And as such, you tend to learn by example. I some respects, some of the presentations tended to reinforce the lecture model. From the other side, the labs did stimulate the hand-on. But many of the labs, because they were designed to update teacher ability, or someone who had a background in physics, weren't necessarily directly transferable as examples to student use.

Researcher Despite that, you still find yourself doing more lab activities in your own curriculum?

Fred Yuh, and part of that may not be driven as much from UPDATE as driven by the general environment of trying to do that. With the Ed reform in this State, there is a strong impetus to change teaching styles anyway. What UPDATE has given, that's why I can't treat it in isolation, it's given me some resources to make that transition easier.

Researcher What effect do you think your participation in UPDATE has had on your students?

Fred Hmm. I can't say. I'm trying to think of something other than I said. The obvious effect is that they are being presented, and I'm able to give them experiences that they wouldn't have had if hadn't been involved in UPDATE. Uh, there are material resources that we didn't have before. One of the big resource changes was the ability to borrow equipment from local campuses. Not the least of which was liquid nitrogen. And, uh, the unit on cryogenics and on heat and temperature that I was able to provide my students with was because of that. And, the sharing the sharing of teaching techniques with other participants certainly affected that particular unit of thermal physics.

Researcher	So, you regularly use the kit and the stuff you got from UPDATE, plus you borrow things from the Boston site.

Fred	Oh, Yes. Yes. Definitely. Without that, I wouldn't be able to get halfway.

Researcher	Would you have used these if you had not participated in UPDATE? Or, would they not be available to you?

Fred	I'm not convinced they would have been available. And, uh, I probably would have felt uncomfortable making an effort to borrow them. Next year we are setting in the Resource Center and I have a hand in choosing some of the materials that will be there, so I know there will be a massive effect of having materials that I've only wished to have in the past. Uh, every teacher in our program will be receiving a graphing calculator and the Resource Center will have calculator based laboratory equipment and sensors so that this would massively affect our ability to have our students make measurements and analyze those measurements.

Researcher	Speaking of students, If I were to ask your students to show me work that they have produced using UPDATE ideas or materials, what do you think they would show me?

Fred	I'm not sure they could. Because I never really identified what we have been doing with UPDATE. I'm not even sure they would be aware of what UPDATE is. I would be hard pressed to say they could identify something, because they wouldn't have known what was there before.

Researcher	OK. Well suppose you asked them to produce a piece of work that you knew was UPDATE related, what would that product be? Or would there be any?

Fred	Hmm. At this point, I'm not sure there would be any. Unless, as I say, it was with the thermal physics. Um, I was unable to use many of the things that were presented in my classes because of the level of the classes.
Researcher	So the material that was presented in UPDATE was more for your own enhancement rather that directly applicable to the classroom?
Fred	Right, and my ability handle student questions, and stimulate some student interest in areas that normally wouldn't have been covered.
Researcher	You worked on some teaching units with your group, especially during the Academic Year Meetings. Are you using those units?
Fred	Oh, definitely. Definitely. Let's see. I did some units on energy with the Genecon. And I've used that quite extensively. As well as some units with electrical wiring and electromagnetic. Uh, as I've mentioned, the heat and thermal material. Many of those demonstrations and some relatively basic conceptual exploratory labs are in that material. Some materials are for optics. We have started an astronomy club where we have students who regularly use a telescope we build at the school but also making use of a telescope at a local private school. And that connection was only made through UPDATE. In addition, I have connections now at the Museum of Science because of UPDATE, with their astronomy section. When the comet came through, many of the contacts and connections and sharing that took place and really enhanced the experience for not only my students but my family as well.
Researcher	The units that you are doing, are they standing alone or are they also, scattered throughout your curriculum?
Fred	Yuh. To identify something that was uniquely UPDATE would be impossible. It's a little bit here and a little bit there. It's very pervasive. It's not something that I could say, here's a unit.

Researcher	Where do the units come from? Are they something you developed or are they pulled from the laboratory work you have done at UPDATE?
Fred	It's a synthesis.
Researcher	What about the skills that you have used in your teaching that can be attributed to UPDATE, for example breadboarding?
Fred	I had done those before. In many cases the type of activities that we did in the lab, I was already using to one extent or another. And what UPDATE did was maybe enhance my use of them.
Researcher	We mentioned the spin-offs that have come from UPDATE. like the rockets. Can you think of any other spin-offs?
Fred	I'm trying to make a distinction of what would be a spin-off. Well, physics Olympics. Some of the activities in the physics Olympics, in fact, some of the challenges, I helped design the Northeast Physics Olympics this past year and a couple of the event were designed after experience in UPDATE. Uh, another area I've tried this year, based on my connections with other people in UPDATE, I took my students to an amusement park. Actually, I gave them part of their final exam there. Some of the materials that I gathered I was able to share and cross check with some of the folks at UPDATE. In fact, there were a number of teachers from UPDATE who went the same day. As, I said, the extended community, the networking, as far as I was concerned, was a major component because it gave me the resources or the connections. So, if I had question, chances are I know who to call. I went beyond the teachers I was working with, it right to the professors and instructors who were involved in the program. Let me give you another spin-off. Dr. Larry Young gave presentations in Boston last summer, and uh, about space physics and space physiology. Now, we had an informal discussion during it when he kind of mentioned that he was interested in becoming involved in stimulating some research through the space grant consortium that he was the director of. That conversation led

to development of a major prize at the Massachusetts State Science Fair, because I was able to coordinate, put him in touch with people. And that prize included a trip to watch a shuttle launch in Florida. Now this goes on. It's very interesting, because on of my students, one of my engineering students, not only won first place in the State Science Fair, but won that particular prize. We just went to luncheon this past week which he presented his project, which was on the reconfiguration of a wing to increase its lift capability without having, uh, needing the flaps which aircraft currently use with all those mechanical linkages. He developed a vacuum system that could reduce the separation of air flow over a wing at high attack angle. Now, this project, I was able to help him with because of some of the connections that evolved over the three years of UPDATE, although this wasn't a topic, but it is space physics. He not only won the first prize here in Boston, but reason I was in Tucson Arizona, was as his chaperon, as he took the top prize in the he international science and engineering fair. I've got to admit, that this is probably, well, UPDATE has something to do with this. He was using a wind tunnel at MIT, which was partially due to some connections which I had to another group called the New England Science Teachers, who also had teachers in the UPDATE program.

Researcher How about your attitude? Has your attitude changed in any way, either towards teaching physics, physics, or in any other way?

Fred I would be hard pressed to even identify it. Look, when a person loses their mind, they are the last to know. When a person has some changes that occur of a substantial nature, I don't think they would notice it. Many of my students don't necessarily recognize what I, or any of the other teachers have done for them, or helped them, because it's become so much part of them they can't separate it.

Researcher You have already mentioned that your confidence has gone up.

Fred Yes.

Researcher	So that would certainly be a positive change.
Fred	Yeah. The area that I still have some major deficiencies in, my mathematical talents, cause I really didn't exercise them or develop them, but I'm working on that.
Researcher	I think that's true for a lot of people. Do you think your students' attitude has changed in any way. For example, do you think they are more excited or interested?
Fred	I think they have to be. I think if I'm excited, I can't see that I can't communicate that. I've been told that that's one of the largest effects that I have on the students, by themselves, they usually tell me that.
Researcher	Which is what?
Fred	That they like my class because they think it's exciting.
Researcher	I would like to ask you about the program a little bit. Can you tell me specifically what aspects of the program helped you to enhance your physics teaching?
Fred	Hmm. (Pause.)
Researcher	Let me read you a list. Just tell me the extent to which each has had an impact on your physics instruction, and perhaps in what way. You can respond in any way you wish. The laboratory part of the program?
Fred	Yes. That had an effect in certain respects. As I have said, many of the lab experiences weren't directly transferable to my teaching assignment. But at the same time. I think they prepared me to take on other teaching assignments.
Researcher	The lectures. You have already said that they were Lecture mode?
Fred	Yes, they didn't actually serve as a model of what might be an effective teaching technique with the students that I deliver services to. Uh, my students object to lecturing. In fat, I find that if I find myself talking or any longer than five or

	ten minutes, they will stop following, even if they look like they are following, they aren't.
Researcher	How about the Resource Center? You guys are putting one together now right?
Fred	As far as I'm concerned, that's probably going to have the primary effect. It have the largest effect on what I'll be capable of doing after this year.
Researcher	Is that because you will have resources that you wouldn't have had otherwise?
Fred	Exactly.
Researcher	Networking with other teachers. You have already said you thought it was important.
Fred	Yes. This is consistent with the development of an e-mail network, and an electronic community that wasn't in place when this program first went into operation. So, uh, now I have some people who I've met personally and I'm maintaining an e-mail link with. So that helps to get ideas. It minimizes the isolation we all find in our classrooms.
Researcher	Are you the only physics teacher in your school?
Fred	No, there are three of us. We're even isolated from each other. It's a matter of scheduling and time. There isn't any time in the school year to sit down and talk for more that a few minutes at a snap.
Researcher	How about the UPDATE staff?
Fred	They've been fantastic in offering assistance and in offering ideas, and in offering to help find things whenever I've had a need to find materials.
Researcher	How about the teacher demonstrations that occurred during the program?
Fred	They were helpful. Uh, it was a matter of sharing. I was able to not only present some ideas that I had, but I was able to see some very fine ideas and presentations that probably enhanced my own technique. That

probably was a major thing. I think that I put on some very nice presentations because of the wonderful people I have been able to copy.

Researcher How about the field trips?

Fred It was mixed. There weren't enough of them. Those that we did do were OK. The industrial tour was helpful. I saw some facilities and material I hadn't seen before. I'd say that the field trips were very helpful in expanding my understanding. And I've carried, wherever possible, an small camcorder, and I've used clips from those videos in presenting information in my classes. Usually, instead of my using it to present information, I use it [in] response to student questions.

Researcher Are there any other aspects of the UPDATE program that you think contributed to the enhancement of your instruction?

Fred The residential week was an effective experience because it did put us together with some people in a social as well as professional atmosphere. And that community building, I considered important. No one understand what a person does except another person who does the same thing. And, it was nice to compare and get the support that you knew you weren't crazy when you would discuss certain problems you've encountered or solutions. At the same point, you were able to get some ideas to maybe deal with those problems.

CHAPTER 7

INDIVIDUAL INTERVIEW SUMMARIES

Interview Summary #1: Helen

In Interview #1, the participant, Helen, is in her words, a "crossover teacher." She was trained primarily as a chemistry teacher but found herself in the position of having to teach physics. Her need for quality training in physics was the primary reason she cited for participation the UPDATE program. In the interview, Helen claims that participation in the UPDATE has affected her physics instruction in several ways. The evidence for her claims can be seen in several areas.

Products

Helen didn't cite specific examples of student generated work, but did explain that her students "were happy" for several reasons. To begin with, Helen claims to be teaching concepts that she previously had not taught, such as the Heisenberg Uncertainty Principle. She also states she is more comfortable with the mathematics associated with the new concepts she in teaching. In addition, she attributes her work with UPDATE to the success of one her students with the Chem SAT II standardized test. However, her primary response is that she is generally more comfortable teaching UPDATE topics and as a result her students are finding more success in class and on standardized tests:

> Last year we used Brown & Lemay, which is supposed to be an AP chemistry book. I used it for my honors students at Lynnfield. We did a lot with the Heisenberg uncertainty principle, we did a lot with the quantum mechanics because that book has an awful lot of the mathematics that is used with the quantum. It was very easy for me to understand the constants. It was very easy for me to apply the math because we used that in UPDATE. So when I work with the kids, the kids could do that work and you know what? I had a student who got an 800 on the chem SAT II. And I had twelve students who took that. With that book and the depth that it goes into, especially in that area, I didn't have a kid who was under 690 for the SAT II. Most of them were 770 or 780. And I know it was because I could, very quickly, have a handle on these harder things, because this is an AP book. Yet I have never taught AP and the chem Ii class had mostly been organic but now I can swath into the physical chemistry that type of book does. I could not have done that without having to stay up until one o'clock in the morning. That was one of the reasons that they hired me because I looked at the book and I said I could do it. So the kids were happy. There is clarity with my explanations. I could talk about that kind of thing.

Helen does cite a specific spin-off product attributed to UPDATE. She explains that she and a colleague collaborated on an interdisciplinary rocketry project that was highly successful.

Researcher	Have there been any spin-off products or "daughter" products from UPDATE, for example have there been any activities or student products that have arisen because of your participation in UPDATE?
Helen	The rocketry. The rocketry that we did, Mark Green from across the hall here participated in UPDATE this year and even though he teaches the physics, he and I made our joint project the rocketry with his honors physics students. And we did a

really nice job, I really must say. And, the kids enjoyed it. It was all after school, extra, for them. But what we are going to do next year is we're going to do an integrated unit where it will be part of his class and my chemistry students are going to study the solid state fuel as the chemistry contribution and his students are going to do the rocketry part. Then we are going to blend the two classes together and make it joint project.

Physical Resources

Helen states that she has not had the need for the Resource Center at the time of the interview, but hopes to use it in the future. In terms of using other materials from UPDATE, Helen is using both teaching units and equipment from her UPDATE kit.

Researcher — Are you using teaching units? When you were in your group in Lowell, you guys worked on teaching units. Are you using any of those now?

Helen — Definitely. There is a lot of good stuff. I have everything categorized at home. I have my UPDATE shelf. I know just where to go for what. And uhm, there were some things presented I'll never use, but there is plenty that was good. There was plenty that was good. There was some stuff that was just too esoteric for me to want to use. I know I can have my husband build some of the contraptions that people came up with, like for circular motion. And it was like wow, I would never have thought of that. But it's so simple and now I can utilize that.

Researcher — In your physics classes or in your future physics classes, what physical material would you be using from UPDATE?

Helen — Yes, all those magnets. We got the Kits that were really good. The superconductivity thing. Which, my first project was on buckyballs. I did an integrated project with the chemistry of buckyballs along with the superconductivity from the physics perspective. And the kids made the buckyballs, had to analyze the structure and had to come up with a use of it. So they first had to totally understand this, and then have the historical background. And they came up with encapsulating medicine in the buckyball and adjusting it and everything. But they loved the superconductivity part. That kit is very nice. I did a project at the museum of science last fall. Another teacher and I made a workshop for physical science teachers in the area which ran for a day. So we had to work with he scientist, the people who were in the museum. They have a very nice superconductivity demo that they do, which is no better than what we do. And yet they are the museum of science. So my students liked that a lot. So that's something that I would never have bought.

Ideas/Concepts

Helen cites numerous examples of her use of UPDATE related ideas or topics. She states that she has changed her physics curriculum, not so much by adding or subtracting topics, but by filling in the blanks in her existing curriculum. She goes on to say that UPDATE has given her the tools necessary to teach physics in a more complete way because she now has the breadth of knowledge to teach what she previously did not understand.

Researcher — So when you teach physics, do you normally have a set curriculum, something that is produced by the school, or you follow the book or something?

Helen — Yeah. Yes.

Researcher — Did you change any of that, or rearrange, add or subtract something because of UPDATE?

Helen Yes I did. Like I said, I was able to uhm, I was able to go into some aspects more deeply, because of the UPDATE, where I was scared to try before.

Researcher Like quantum?

Helen Like the quantum, I could look at some of the labs that had to do with the electromagnetic spectrum. I could use that more efficiently. Because, the students I had, I had as chemistry students, so I couldn't repeat a chemistry lab for them. If I hadn't had them, then I could pull this lab in and I could sort of like cover my tracks, so I had to do something different. I could use the spectroscopes more effectively. I wasn't really good at that from the physics point of view to understand why they wanted to find wavelengths, why they wanted to. . . . We found Planck's constant. That I didn't do in chemistry. I was more interested in other things . . . for the chemist.

Researcher So, you mentioned the quantum physics as something that you changed in your physics curriculum. Were you doing that at all before?

Helen I was skipping it.

Skills

Helen indicates that she gained specific skills in UPDATE such as breadboarding, the analysis of quantitative data, and the use of some technical laboratory equipment such as oscilloscopes.

Researcher Since we are talking about that, so one of the skills that you have learned in UPDATE was breadboarding.

Helen Absolutely.

Researcher Were there other skills that you are bringing back to the classroom?

Helen	Yes, the analysis of the quantitative data. The way they do that at U-Lowell is very interesting. The percent error. How they do graphical analysis. That was something I hadn't done in a long time in the physics end. So what I was doing uh, much more basic, now I can understand it totally and decide how far I want to take it. At least now I got it. They leave a lot out. You know in the ancillary materials, they go from one paragraph to another paragraph and whoa, where did they go? How did they get here? I find now I scan the material and I get it, I understand. Before it was like I had to read other books to try to bridge this. I don't do that anymore.

<u>Attitude</u>

When asked whether her physics teaching had changed because of her participation in UPDATE, Helen emphatically implied that it had.

Researcher	Right. Do you think you have changed the way you teach physics? Not just what you teach, but how you do it?
Helen	Absolutely! And that is more because, interacting with other physics teachers you share a lot of information. They gave you hints, you gave them hints. You got to discuss what you were doing and that only made it better. So in the summer, when you were away from your ten months of teaching, you could be more reflective and talk about what you had done, then the helpful hints came in. They either confirmed what you were doing was fine, or somebody always had some helpful and interesting that was a great little addition. And some people would say that they don't do something anymore because it's never worked for me, you could say, you know it hasn't for me either but I figured I had to have it. And you could just say that wasn't the best approach to take.

Researcher	Can you give me a specific example of how your teaching in general has changed? Like are you doing more laboratory work now than you were before?
Helen	Well I always did a lot of lab work, but uh, I think what has changed is anytime you just add experience on to experience you refine and you improve. So three solid years of this has made me really improve.

Helen also indicates that a major change was the elevated level confidence she had in teaching physics as a result of participation in UPDATE.

Researcher	How about your confidence in teaching physics? Has that changed since the UPDATE program?
Helen	With the three years of this program, definitely. Three years of anything as intense as this would definitely do that.

Finally, Helen summarized how her instruction had changed by explaining that she had a much better perspective of physics, she has more confidence in teaching physics, therefore she has added more physics concepts to her curriculum, most of which are UPDATE related.

> I think that every time now I read something and every time I think about a lab, I have a much broader picture of what it could do for the kids. What it could do for expanding our knowledge. Uh, I can look and the harder material. I can look at anything on electricity now. You don't find a course in electricity, like one of the things that you have to do to be certified in physics is you are supposed to find something on sound, on light and on electricity. You don't go into a graduate school and find an electricity course it can have a lot of electricity but it's not called electricity it's not called sound, it's not called light all those things make you a master of the trade to be called physics certified teacher. And they're all part of UPDATE as that all helped me get my certification faster. But they did accept components that UPDATE provided where they were saying I didn't

> have all of the gaps filled in, because they wanted a course on sound. You don't find that. You don't find the physics of sound but we did a lot that I could show them what we had done and they said "check it off, check it off."

Interview Summary #2: Richard

Richard, as Helen in the previous interview, was not originally trained as a physics teacher. In fact, Richard began his teaching career as a junior high school teacher with an undergraduate degree in political science. He later became State certified in physics and now teaches high school physics.

Richard states that his teaching has been positively affected by his participation in the UPDATE program. The evidence for Richard's claim can be seen in several areas.

Products

Richard states that because of his UPDATE experience, he includes more electronics in his physics classes, but cannot cite any specific examples of student generated work. He does, however, cite examples of teaching aids he has constructed from UPDATE ideas or materials:

> Ah, I don't know other than the stuff dealing with electronics. As I say, most of the information, well, I made a methanol cannon which I demonstrate to them and use Newton's Laws and trajectory and that kind of stuff which was a result of UPDATE. I made a Geiger counter that was part of the energy unit. That was part of our unit in nuclear energy. And I made an air rocket.

Physical Resources

In a discussion of the amount of time Richard's students spend doing laboratory activities he mentions that he uses the kit material he was given at UPDATE.

> Yuh. I think it's more (time in lab). You know, I know it's more. I have a good classroom set up for it though, you know. I have a combination classroom/lab set up. One end of the room is lab tables and I can just move over to them. I can have little things set up. I can have demos and combination demo/labs, and things like that with toys and hardware collected from UPDATE that are great to work with. Even the multimeters that I got are out all the time.

He also admits he uses UPDATE material frequently and has ordered more spectroscopes similar to the one he was given in UPDATE.

> Well I certainly use the magnets all of the time. In fact, I just ordered a bunch of the Project Star spectroscopes, which are terrific. They're right on the money. Compared to the ones we used to use in IPS and still use in physics which are, you know, a toy. You know, I have such a pile of junk. It's hard for me to tell what I've picked up from UPDATE. I just sort of pull stuff out when the time comes.

Ideas/Concepts

Richard states he has changed his curriculum to include more electronics and communication, which were UPDATE topics. Although he also states that his physics curriculum is pre-determined by his school, so he essentially augments pre-existing curricular topics.

Richard	Well, I do a lot more with electronics. A lot more. I really never did anything before, but as a result of the work with breadboards and things like that I can do a

lot more than before, and it's nice to work in lab activities with that stuff.

Researcher	Right, um, some of the topics might be considered outside of what is normally covered in high schools.
Richard	Yeah. For example, I think trying to integrate communications into a standard physics curriculum, well, I haven't quite figured out how to do it yet. It's a really terrific idea, you know, taking the idea of encoding messages and the various electronic ways you can do that, and letting people know what the future is for communications coming into their homes. For example, the fiber optic cables or even the coax cables from your cable TV. I think we've just touched the surface in that capacity. And knowing the fundamentals of electronic communication, I think it's a good idea there.
Researcher	So what do you do in electronics that you didn't do before?
Richard	Well, I do more with fundamental electricity. You know, from Ohm's Law up. And a little more with communication and solar cells, modulating signals, and I make that little uh, transmitter with a flashlight and a solar cell like I saw demonstrated.

Richard also states that he brings UPDATE ideas/concepts to his physics classes through his ability to answer student questions for which he was previously less well prepared. He says,

> I know a heck of a lot more. Now I really do space physics as a unit. But, it's certainly something I'm conversant in now. Questions about that come up all the time. Like if there is a shuttle launch or something, at least you can say something. And, you can say something first hand about the people who went up there. I think the astronauts who spoke to us were fascinating.

In addition, Richard claims to spend considerable more time doing lab activities in his physics classes.

Researcher If you could characterize the percent of time that you spend in the lab that is more than you spent before, would it be like ten percent, twenty percent, or something else?

Richard Probably twenty percent more, But that's a real reach. I really couldn't put a number on it.

Finally, Richard networks with other teachers more than he had before, which he claims has helped his instruction. When asked about networking with other physics teachers, Richard responds:

> I do more than I did before. But again, because of my proximity, not as much as other people are doing. I mean, I can tell just from the conversations that other people are doing a lot more with it than I am.

When the researcher remarked that Richard had commented that talking with other physics teachers was something that helped his instruction, Richard responded: "Absolutely."

Skills

Richard has changed his curriculum to include more electronics and he states that his ability to do some of that comes from new skills he has gained in UPDATE.

Researcher Thinking about the skills that you use in your teaching that can be attributed to UPDATE, like breadboarding, for example. Have you used a breadboard before?

Richard Nope. Never even heard of one. But I'm damn good at it. Well, I think that electronics and electricity in circuits is a special kind of intelligence. Some people have it and some people don't. Uh, and when you do it with kids, there are some kids that can look at a schematic and look at a circuit and see the connection, and some kids just can't. I do some of that with ninth grade kids in an introductory science course and you can tell the ones with whom it has clicked, and those that haven't. They look at those wires and they don't see any connection between what they have drawn and what they have in front of them. So I do a lot more with wires than I did.

<u>Attitude</u>

Richard states that, overall, participation in UPDATE has had a positive effect on his instruction. Although, part of its effect was realizing his academic limits.

Researcher	So overall, just to sum up, how would you describe how the program has affected your instruction?
Richard	Well, it had a very positive effect on my instruction. I can't think of any negatives, certainly. Uh, it's had some sort of sobering effects on me but I sort of knew that anyway. You know, in terms of knowing my limits. Uh, and it just worked out well for me because I was working on a plus thirty anyway, so it was a great opportunity for me. And I enjoyed going out to U-Mass a lot. As a result, my son is going out there now. I was impressed with the place and impressed with the price.
Researcher	How about personally? Has your attitude towards teaching physics changed since your participation in UPDATE?
Richard	Well, I think I have a hard time dealing with it myself. Uh, in the topics in quantum, for example, I realize how little I know and what my chances are of ever knowing anything. And I sometimes have a hard time coming to terms with that. But at the same time, I'm fairly successful, so I sort of have to put that aside.

He also states that his knowledge and his confidence have improved because of his participation in UPDATE. As a result he is doing more laboratory work with students and is more confident is answering student generated questions. He said,

> It's hard for me to put my finger on it. I think I'm just able to deal with a much greater variety of topics and a wider variety of questions that come up than I could before. But it's very hard to give you specifics.

Asked if he was feeling more confident, Richard replied, "Absolutely!"

Interview Summary #3: Cheryl

Cheryl was originally trained as a high school chemistry teacher and has found herself in the position of also teaching physics. Currently she teaches both chemistry and physics.

Products

Cheryl cites several examples of activities or physical projects that she and her students have generated in both her physics and chemistry class which were UPDATE related. Most of the activities Cheryl cites are related to quantum physics, which was one of the topics offered during the third year of UPDATE. She said,

> In my general physics class we did a section about treating the electron as a wave as opposed to a particle. And in lab we made this model showing, we picked a piece of paper to be a certain wavelength and then they made the energy levels, the second energy level would be twice as long, the third would be three times as long and we made rings and put them on paper. We showed where the different energy levels were and areas where they wouldn't find the electron. We talked about why that wouldn't happen. We talked about the electron being a wave and things like that.

> I think that worked pretty well. And that was a concept that was really hard for the kids. They can kind of picture the electron as being a particle with no problem, but where does this wave idea fit in? So we did that, and it worked out really well. And my chemistry kids, and this just happened to fit really well with my chemistry. We did some work with probability. We talked about probability and finding the electron in certain places outside of the nucleus. Then they came up with some games using probability and they related that to finding the electron and the probability of finding it here or there.

Physical Resources

Cheryl emphatically stated that she frequently uses UPDATE related equipment, such as items from her UPDATE kit. When asked if she used the materials from UPDATE (for example, the kits received by participants), she replied:

> Oh, definitely. And I've actually lent them out to people in my department who are teaching physical science this year when they were doing different things. Oh yeah, I have this little hand generator, all kinds of stuff like that. We have just instituted physical science for the ninth grade, and so one of the women who was teaching that would come in and say, "do you have any of this or that?" And I would say, oh yeah, and take out stuff from my kit.

Asked if she used the kits regularly, Cheryl replied, "Uh huh, the chapters, we take in out and use it." And, asked if those materials would be available at her school without her participation in UPDATE, she said,

> Some of it, no. I mean, we have some meters. We don't have the nice multimeters like we got in UPDATE. Now, we have four in my school, because I have two and Pat has two. We didn't have anything like that before. We just had the old meters you plugged into the circuit, you know. We didn't have anything like the multimeters. So, some of that stuff we didn't have at all, and

> some of it was just added to. Not a whole lot, like the lasers. Those pocket lasers were good for a couple little experiments, and that worked out nicely. That allowed me do a lab, not just a demonstration. I broke the class up into groups, a little bit large maybe. But at least they all got to mess around with the lasers a little bit.

Ideas/Concepts

Cheryl indicated that UPDATE has helped her to rethink her curriculum and she spends more time on UPDATE related topics such as quantum physics. She states that she uses the ideas in teaching both chemistry and physics. Asked if she rethought topics covered in the physics curriculum because of her participation in UPDATE, she replied:

> A little bit. I did more of the nuclear chemistry stuff due to the modern chemistry that we did. I also did more in physics. I did a whole section on nuclear reactions and stuff like that that I had never done before. And, brought in a lot of stuff with the structure of the atom and things of that nature, because I thought it would be useful to the students because I teach a general level physics, for the last couple years. I taught the structure of the atoms, how nuclear reactions worked and what radiation is, and things like that which are really helpful to them.
>
> Uhm, I added in the nuclear stuff in the physics curriculum. I supplemented what I was already doing with atomic structure in my chemistry curriculum because that fit in really nicely with the stuff Roy did last year. So, I didn't leave anything out of chemistry, but I did add things in. More details in a couple of activities, some of the stuff that I developed for the program I used and tested out in those classes. In physics, it's hard to say if I left anything out because we changed physics books. We went in to the conceptual physics for the general level, and I hadn't used that book before so that was kind of new and we were just playing around and seeing what we wanted to do. I probably didn't do as much mechanics, but for

> that level I think that was OK because I was looking at that general level as things they might actually take out and use. Things that they could use for maybe job skill or even just voting and things like that.

She is also using the teaching units that were she developed during the Academic Year Meetings.

Asked what teaching units she was using from UPDATE, or if she was using bits and pieces of the UPDATE materials, she replied:

> I'm using bits and pieces, I think. I have used things, as I've mentioned, from the quantum. I have used quite a bit of that. I used a little bit about space. I don't do a lot of astronomy or space physics, but the kids always have questions about black holes and this and that, space travel. Those come up from time to time and we do discuss it. I definitely use the energy stuff in both the physics and the chemistry, and a little bit about communication now and again when ideas come up, but not as much as the others.

Skills

When asked about skills gained at UPDATE, Cheryl claims to have become more comfortable with the use of electric circuits. The researcher asked if any skills, particularly physics, used in her teaching came from UPDATE. Cheryl said,

> Well I will say that I am much more comfortable doing the electrical circuits and stuff from doing that, because that was an area that I was really weak in. And having done all of that with the communications with Monroe, I felt much more comfortable reading those diagrams and troubleshooting when kids have little circuits made up. Oh yeah, that where your problem is. Or, look over here, that may be a problem. So that has helped a lot. Not necessarily doing those exact things, but using that particular skill.

Attitude

There are several examples Cheryl offers throughout the interview which can be generally thought of as a change in attitude. First, Cheryl, states that she feels more prepared to answer student questions. She cites her improved comfort level with the subject matter as well as her improved confidence in physics.

> I think that it enhanced my background so that I can talk more comfortably about different subjects. And, I think it's made me aware of more things to do in the lab and made me look toward doing more hands on work and more lab work with my students.

Researcher	Do you think there has been any other changes in your physics teaching due to your participation in UPDATE?
Cheryl	I think for me, I have a better background so I'm better prepared to answer off the cuff questions than I was before. Or, if I get a question that I don't necessarily know the answer to, at least I have more resources. Like, oh, I remember that, or I remember seeing something about that, or I have places to go to look that up.
Researcher	How about your level of confidence?
Cheryl	Much better. Much better. Definitely. And again, I'm probably one of the people who have had maybe the weakest background because my undergraduate, all I had was general physics and that's when I first started teaching physics, was just from my general physics from college. And then when I took my masters at Worcester Poly Tech, I had some mechanics, some E & M, and some modern physics, so that was a little better. But the UPDATE program and actually the institutes that they had years before really helped to fill in a lot of the gaps that I had.

Cheryl's enhanced comfort level with physics has also facilitated a change in instruction. She indicates that she is doing more laboratory or "hands on" work with students:

> I think that I'm moving more towards more hands-on things and kind of small project sort of things. Part of that is because of UPDATE because I feel more comfortable with equipment and things like that, ideas for experiments and projects. Part of it is just the general trend in Ed reform and stuff. Both of those things kind of mesh and are changing those things a bit.

When asked if she was spending more time in the laboratory, she said:

> Right. Trying to. I think especially like when I teach the general level or the lower level. If you can do something concrete that they can touch and put together and see how it works, their understanding of it, or their excitement for it seems to be a lot better than if you just kind of talk about it conceptually and, you know, just talk back and forth about what do you think will happen or why you think this will happen. It's better when you can attach it with something with something for them, particularly.

Interview Summary #4: Fred

Fred has participated in UPDATE for all three years. He was not trained as a physics teacher, however, he has a strong background in the physical sciences. He currently teaches conceptual level high school physics as well as a high school engineering course.

Products

Although Fred states that students would not know if they were working with UPDATE related projects, he concedes that his students routinely work with UPDATE ideas and equipment. In the beginning of the interview, Fred discusses an UPDATE related bottle rocket activity in which his students were involved.

> Well, for instance, the space science led to with rockets made from soda bottles and that's become an early September activity where not aerodynamics would be discussed and worked upon, but there would be an opportunity to run something like a physics Olympics competition at the local campus U-Mass Boston. And we are working on a day in early October to bring students in and have a field day using these water rockets. Usually we wait until field day activities late in the spring, but now we are stating earlier.

<u>Physical Resources</u>

Fred claims that he uses UPDATE equipment routinely and that his students also have the opportunity to use the equipment.

> Well, one of the most significant is that all the materials that I have received as part of Kits during the three years, have found their way into the students' hands. Everything from the multimeters to the various demonstration devices, where the students are using them.

He also states that he believes the UPDATE Resource Center will be very valuable to his teaching when it becomes functional. The researcher asked Fred about the resource center, and Fred replied, "As far as I'm concerned, that's probably going to have the primary effect. It have the largest effect on what I'll be capable of doing after this year." The researcher asked, "Is that because you will have resources that you wouldn't have had otherwise?" Fred replied, "Exactly."

Ideas/Concepts

On several occasions during the interview, Fred cites examples of how the UPDATE program has affected his instruction. He states that he has changes his curriculum by changing the order of topics to include more UPDATE related topics earlier in the academic year. He also claims that as a result of UPDATE his method of teaching is leaning towards student project work.

> I'm trying to change the sequence. I'm going to start with some concepts in electricity and magnetism. One of the things that appeals to me, I just got a flyer in the mail today, let's see, a program at Kansas State University called Visual Quantum Mechanics. I wouldn't have had any interest in this if it hadn't been for the UPDATE program. Uh, they're field testing material to teach quantum mechanics, or to explore the quantum world. And they say it's for non-science students. Hopefully, I'm going to try to take advantage of that.
>
> I try to have more projects or activities than I did before. But one of the limitations is a real one, and that's the limitation of facility and resources. The financial situation is very limited. I might have about five or six hundred dollars to spend every year. And, the most sophisticated computer I have is a Mac 512, which was built in 1985. And most of the computers I'm using are Apple IIEs or II Pluses.

When asked by the research if he was changing your teaching methods a bit by moving towards project work, Fred answered: "Yes. But the other point is that I'm willing to cover normally would have been relegated to the end year. I'm incorporating them into discussions early in the year."

Asked about the possible effect of his participation in UPDATE on his students, Fred states that he is now able to offer students experiences not possible before his participation:

> The obvious effect is that they are being presented, and I'm able to give them experiences that they wouldn't have had if hadn't been involved in UPDATE. Uh, there are material resources that we didn't have before. One of the big resource changes was the ability to borrow equipment from local campuses. Not the least of which was liquid nitrogen. And uh, the unit on cryogenics and on heat and temperature that I was able to provide my students with was because of that. And, the sharing the sharing of teaching techniques with other participants certainly effected that particular unit of thermal physics.

Fred goes on to say that he is using teaching units extensively that he and other UPDATE participants generated during the Academic Year Meetings. Then the researcher asks if Fred is using the teaching units he worked on with his group during the Academic year.

> Oh definitely. Definitely. Let's see. I did some units on energy with the Genecon. And I've used that quite extensively. As well as some units with electrical wiring and electromagnetic. Uh, as I've mentioned, the heat and thermal material. Many of those demonstrations and some relatively basic conceptual exploratory labs are in that material. Some materials are for optics. We have started an astronomy club where we have students who regularly use a telescope we built at the school but also making use of a telescope at a local private school. And that connection was only made through UPDATE. In addition, I have connections now at the Museum of Science because of UPDATE, with their astronomy section. When the comet came through, many of the contacts and connections and sharing that took place and really enhanced the experience for not only my students but my family as well.

Skills

Fred states that he did not gain any specific skills in the UPDATE program. However, the UPDATE program enhanced the use of his skills. The researcher asked about breadboarding skills acquired in UPDATE, and Fred said,

> I had done those before. In many cases the type of activities that we did in the lab, I was already using to one extent or another. And what UPDATE did was maybe enhance my use of them.

Attitude

Fred cites two basic areas in which his attitude was affected by the UPDATE program. First, he states that he is more confident in physics and that he is better able to address student questions and therefore generate student interest in physics. Secondly, his enthusiasm has been enhanced as he is networking with other physics teachers to a greater extent and is able and more interested in reading more literature on UPDATE related topics

> Well, let's see. Well, one of the areas is not so much the subjects that we're taking in UPDATE, but the opportunity to network with teachers across the state and the region. That networking has continued and occasionally we've helped coordinate some cross fertilization of ideas. The other area of interest is that some of the material helped to support my understanding of the mechanics of satellite imagery. I'm endeavoring to set up a satellite receiving antenna on our roof. But the next level is image analysis. I was able to get out to Tucson Arizona and visit the center for image processing and education. They're developing new software that will work in our computer here at school. I also had the opportunity to visit some of the observatories out there and if it hadn't been for some of the astrophysics presentations, I would

have been lost in understanding what I was seeing.

And the other thing is that I'm more comfortable talking about quantum mechanical effects and relativistic effects. Because now I have some connections between theory and application, and that is something I didn't have before. In many cases it was just a mathematical, well it was not something that I would have considered of interest to my students. But that has changed. The other effect, I think, is that I'm reading more in the literature than I did before. I can understand some breaking theories in various areas of optics, quantum physics and astrophysics which I didn't even have a handle on in the past.

When the researcher asked if material presented in UPDATE was geared more toward improving Fred's own skills than toward direct use in the classroom, Fred replied, "Right, and my ability handle student questions, and stimulate some student interest in areas that normally wouldn't have been covered."

Next, Fred was asked if his students' attitude had changed in any way; if they were more excited or interested. He replied,

I think they have to be. I think if I'm excited, I can't see that I can't communicate that. I've been told that that's one of the largest effects that I have on the students, by themselves, they usually tell me that. . . . That they like my class because they think it's exciting.

CHAPTER 8

QUESTIONNAIRE

The Focus Group interviews were constructed to identify broad concerns, issues, and areas of the UPDATE program that the interviewees felt were important to them and their instruction. Using this data, individual interviews with a participant from each campus were arranged to explore these areas in more depth. Categories were constructed to assist in organizing individual interview data and a summary of each interview was developed. At this point, we find a remarkable consistency of opinion and self disclosed changes by all interviewees. However, it would be very useful to investigate the degree to which the general population of UPDATE participants agreed with the interviewees.

At the conclusion of the UPDATE program, the program evaluators constructed and administered a questionnaire to all UPDATE participants. The primary purpose of the questionnaire was to collect the data needed to provide a formal evaluation of UPDATE for program stakeholders. However, a secondary function of the questionnaire was to collect data to help determine if the UPDATE program has affected the physics instruction of its participants. (The UPDATE Questionnaire can be found in Appendix A) Therefore, some items included in the Questionnaire can be used to identify pertinent correlations which then may be triangulated with previous focus group and individual interview data. This information can then be used to form an overall picture of the effect of participation in the UPDATE program on physics instruction.

Responses to questionnaire items were placed on a scale from 1 to 5. In the case of items 12 - 21, the scale was as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral/Undecided, 4 = Agree, 5 = Strongly Disagree.

Items 24 - 30 were also placed on a scale from 1 - 5, with the scale being as follows: 1 = Not at all, 2 = To a small extent, 3 = To a fair extent, 4 = To a great extent, 5 = To a very great extent.

The responses to the selected questionnaire items were coded by number and analyzed using standard descriptive and inferential statistical procedures using SPSS software. It should be noted that some questionnaire items are worded in a negative fashion. Therefore, for uniformity of numerical analysis, the Likert scale used to analyze the responses has been reversed on those items. As a result, the first response choice is represented by the number five, while the last response choice is represented by the number one.

Clustering Questionnaire Items

Because the questionnaire was not specifically designed to collect data on the effect of participation on physics instruction, not all of the items on the questionnaire are useful for this study. Therefore, selected questionnaire items were chosen for this study.

The first five items on the questionnaire were constructed to form descriptors of the participants. Item one asks the respondent to identify himself/herself as a member of one of the four University of Massachusetts campuses that is considered their "home" campus. That is, the campus where the respondent participated in the program for the first two weeks of the program as well as the where the Academic Year Meetings were held.

The second item asks the respondent to identify the number of years he/she have been teaching physics. There are four response choices. The first is 0-2 years, the second is 3-5 years, the third is 6-8 years and the fourth is 9 + years.

The third questionnaire item asks the respondent to state the number of years he/she has participated in the UPDATE program. The fourth questionnaire item asks the respondent to identify his/her gender. The fifth item asks the respondent to approximate the percent of their physics instruction which is spent engaged in laboratory activities.

These five items not only describe the respondents, but also act as correlants in this study. For example, considering the first item which asks the respondent to identify himself or herself as a member of one of the four University of Massachusetts campuses, it is possible to determine if the UPDATE experiences on one campus were significantly different from those experiences in any of the other campuses.

The remaining items on the questionnaire were clustered into the five categories used earlier to classify interview data: Products, Physical Resources, Ideas/Concepts, Skills, and Attitude. The items that were selected for each cluster are explored in the following sections.

Products

Products are specific examples of student generated work which are UPDATE related. Item 17 on the questionnaire directly asks about student generated work using UPDATE related ideas or concepts. Respondents are asked to identify the extent to which they agree with the statement, "My students have generated work using UPDATE related ideas or concepts."

Physical Resources

Physical Resources refer to the use of UPDATE materials in the classroom, such as teaching units, equipment from Kits, or items from the UPDATE Resource Center. There are two questionnaire items which fall into this category. Items 24 and 30 both inquire directly about the UPDATE Resource Center and the Participant's Resource Kits respectively.

Respondents are asked to indicate the extent to which each of these aspects of the UPDATE program has contributed to the improvement of their physics instruction.

Ideas/Concepts

Ideas and/or Concepts refer to UPDATE related ideas or concepts used in the participant's high school physics classroom. There are two questionnaire items which comprise this cluster. Respondents are asked to indicate the extent to which they agree with statements 12 and 13. Item 12 states "I spend more time on lab activities in my physics classes since my participation in the UPDATE program," while item 13 states "I rarely use UPDATE related ideas in my physics classes."

Skills

Skills refers to those abilities, primarily associated with the physics laboratory, which teachers have gained or enhanced due to their participation in UPDATE. Examples of skills include breadboarding, and the use of high tech lab equipment such as oscilloscopes. Questionnaire item 14 comprises this cluster, which asks respondents to indicate the extent to which they agree with the following statement: "My physics instruction has improved because I have learned new laboratory skills in the UPDATE Program."

Attitude

Attitude is a somewhat broad category including teacher or student attitude towards physics and physics teaching, as well as the use of specific teaching units or activities that can be attributed to the teacher's participation in UPDATE. Essentially, this category includes any aspects of the participant's physics teaching or physics class which demonstrates a change in view, opinion or attitude due to participation in UPDATE.

There are several questionnaire items which constitute Attitude. Items, 16, 18, 19, 20, 21, 25, 26, all ask the respondent to indicate the extent to which he/she agrees with the following statements:

16. Participation in the UPDATE program has not changed my attitude towards teaching physics.
18. I have not changed my physics curriculum to include more UPDATE related topics.
19. My physics instruction has improved because I have learned new physics in the UPDATE program.
20. I have become more enthusiastic about teaching physics since my participation in the UPDATE program.
21. Participation in the UPDATE program has not changed my overall physics instruction.

Also included in the Attitude cluster are questionnaire items 25 and 26, in which respondents are asked to indicate the extent to which each listed UPDATE aspect has contributed to their physics instruction. Both items concern networking; item number 25 concerns networking with other physics teachers, and item 26 concerns networking with UPDATE staff.

Participant Descriptors

An analysis of the first five items described the population of UPDATE participants. There were 93 participants in the 1995-96 UPDATE program, 90 of whom returned the questionnaire for a return rate of 97 percent. There were 24 participants at the Amherst campus, all of whom returned a completed questionnaire. The Boston campus had 23 participants, 22 of whom returned a completed questionnaire. There were 22 participants from the Dartmouth campus, 20 of whom returned a completed questionnaire. Finally, Lowell had 24 participants, all of whom returned a completed questionnaire.

There was a high population of veteran teachers in the program. That is, 53.3 percent of all respondents had taught physics for more than 9 years. Teachers who had taught physics for 6-8 years accounted for 13.4 percent of the respondents, while teachers who taught physics for 3-5 years accounted for 20 percent of the respondents. Finally, 13.3 percent of respondents taught physics for 0-2 years.

The number of years that teachers participated in the program varied between 1 and 3 years, with 36.6 percent having participated in the program only one year. Teachers who participated 2 years accounted for 38.8 percent, while 25.6 percent participated in the UPDATE program for all three years.

The population of participants was largely male; they comprised 84.4 percent of the overall population of respondents, leaving the female population at 15.6 percent.

Finally, the percent of time teachers spent in the lab varied considerably, as 6.7 percent of the population stated that they spend between 0 and 10 percent of their instruction time engaged in lab activities, while 30 percent spent between 10 and 20 percent. Those teachers who spent between 20 and 30 percent of their instruction time in lab were by far the largest population at 47.8 percent, while 14.4 percent spent 30 to 40 percent of their time in lab. Finally, only one respondent, or 1.1 percent, claimed to spend more than 50 percent of their instruction time in lab.

Analysis of Variance

Four one-way ANOVAs were used to test whether there were differences in responses among UPDATE participants:

1. from different campuses (Amherst, Boston, Dartmouth, Lowell)
2. with different years of physics teaching experience (0-2, 3-5, 6-8, and 9+)

3. with different years of UPDATE experience (1, 2, or 3 years)
4. with different teaching styles expressed as percent of physics instruction time engaged in lab activities (0-10 percent, 10-20 percent, 20-30 percent, 30-40 percent, 50 percent+)

Physics teachers responded to nine 5-point Likert scale items and six other 5-point items. An "overall attitude towards the UPDATE program" score for each teacher was obtained by summing his or her responses to the entire group of selected questionnaire items.

At a 95 percent confidence level, there was no difference in overall attitudes towards the UPDATE program between teachers from different campuses ($F_{3,86}$ = 1.132, p = .341). This suggests that the experiences of participants from each campus were not significantly different. Therefore, subsequent analysis will treat the UPDATE population as one group and not four distinct groups.

The analysis also showed that there was no difference in attitude towards the UPDATE program among teachers with different years of physics teaching experience ($F_{3,86}$ = .257, p = .341). Therefore, as with campus affiliation, subsequent analysis will not consider teachers with different years of physics teaching experience as separate groups.

The number of female teachers accounted for approximately 16 percent of the total population of UPDATE participants. Therefore, there is an insufficient population of female teachers to make valid comparisons. As a result, male and female teachers will be considered as a single group for subsequent analysis.

There was a difference in mean responses between teachers with either 1, 2, or 3 years of UPDATE experience ($F_{2,87} = 7.304$, $p = .001$). A comparison between teachers with 1 and 2 years of experience indicated no significant correlation ($t_{65} = -2.52$, $p = .014$). A second comparison between teachers with 2 and 3 years experience also indicated no significant correlation ($t_{55} = -1.37$, $p = .177$). However, there was a difference between teachers with 1 year of UPDATE experience, and those with 3 years of experience ($t_{54} = -3.70$, $p = .001$).

To examine this difference more closely, it is possible to look at the mean response of teachers with either 1, 2, or 3 years of UPDATE experience to each cluster of questions. The clusters consist of questionnaire items classified as Products, Physical Resources, Ideas/Concepts, Skills, and Attitude. The weighted mean response score is also shown following each section. The mean is weighted because some clusters contain different number of questionnaire items than others.

Teachers who participated in the UPDATE program one year had the following mean scores: (on a scale from 1-5, with 5 representing the highest score and 1 representing the lowest score).

Products	3.67 with a standard deviation of .777
Physical Resources	2.85 with a standard deviation of .690
Ideas/ Concepts	3.71 with a standard deviation of .650
Skills	3.85 with a standard deviation of.566
Attitude	3.75 with a standard deviation of .532

Average weighted mean = 3.63

Teachers who participated in the UPDATE program two years had the following mean scores:

Products	3.97 with a standard deviation of .674
Physical Resources	3.03 with a standard deviation of .807
Ideas/ Concepts	3.95 with a standard deviation of .557
Skills	4.30 with a standard deviation of .579
Attitude	4.04 with a standard deviation of .499

Average weighted mean = 3.73

Teachers who participated in the UPDATE program three years had the following mean scores:

Products	4.00 with a standard deviation of .522
Physical Resources	3.15 with a standard deviation of .804
Ideas/ Concepts	4.17 with a standard deviation of .229
Skills	4.30 with a standard deviation of .635
Attitude	4.21 with a standard deviation of .410

Average weighted mean = 4.10

Clearly the highest mean scores belong to the group of teachers who participated in the UPDATE program for three years. This group of teachers may have the highest scores because they have been in the program longer than other teachers and therefore have been exposed to more UPDATE related ideas and activities, and so have been more influenced by the program. Another possibility is that the teachers who participated for three years are those who are more predisposed to accepting new ideas and influences of the program, and therefore chose to participate for all three years.

There was also a difference of overall attitude towards the UPDATE program between teachers of different teaching styles as expressed by instructional time in the lab ($F_{3,85} = 4.585$, $p = .005$). The difference lay between those teachers spending between 10-20 percent and 30-40 percent of their instruction time in lab, ($t_{38} = 3.05$, $p = .004$) and those teachers who spend between 20-30 percent and 30-40 percent of their instruction time in lab ($t_{54} = 3.28$, $p = .002$).

To examine this difference between these groups it is possible to look at the mean response of teachers reporting instructional lab time of each percent range in item #5 to each cluster of questions. The clusters consist of questionnaire items classified as Products, Physical Resources, Ideas/Concepts, Skills, and Attitude.

Teachers who reported spending between 0 - 10 percent had the following mean scores: (on a scale from 1-5, with 5 representing the highest score and 1 representing the lowest score).

Products	3.83 with a standard deviation of .408
Physical Resources	3.17 with a standard deviation of .753
Ideas/ Concepts	3.77 with a standard deviation of .344
Skills	4.33 with a standard deviation of .516
Attitude	3.92 with a standard deviation of .401

Average weighted mean = 3.82

Teachers who reported spending between 10-20 percent had the following mean scores:

Products	3.82 with a standard deviation of .786
Physical Resources	3.17 with a standard deviation of .797
Ideas/ Concepts	4.01 with a standard deviation of .527
Skills	4.04 with a standard deviation of .706
Attitude	4.01 with a standard deviation of .409

Average weighted mean = 3.89

Teachers who reported spending between 20-30 percent had the following mean scores:

Products	3.91 with a standard deviation of .610
Physical Resources	2.97 with a standard deviation of .743
Ideas/ Concepts	4.01 with a standard deviation of .421
Skills	4.21 with a standard deviation of .514
Attitude	4.10 with a standard deviation of .484

Average weighted mean = 3.91

Teachers who reported spending between 30-40 percent had the following mean scores:

Products	3.77 with a standard deviation of .832
Physical Resources	2.62 with a standard deviation of .740
Ideas/ Concepts	3.44 with a standard deviation of .875
Skills	3.92 with a standard deviation of .760
Attitude	3.50 with a standard deviation of .667

Average weighted mean = 3.42

There was only one teacher who reported spending more than 50 percent of physics instructional time in the lab. Therefore, the data associated with teachers who spend 50 percent or more in lab is statistically unimportant.

The highest mean scores reported belong to the group of teachers who spend between 20 percent and 30 percent of their instructional time engaged in laboratory activities. It is this group whose mean scores were significantly different from both groups one and two.

This finding is somewhat surprising in that the UPDATE program is highly laboratory oriented and therefore it would be expected that the group who spend the most time in laboratory instruction would have the highest mean scores on the selected questionnaire items. A possible explanation is that the majority of teachers have found that 30 percent is the optimal time that they feel is important to spend in the laboratory. This is plausible because the teachers who report spending between 20-30 percent of their time engaged in lab activities also make up the largest population of UPDATE participants at 47.8 percent, while those who claim to spend more than 30 percent make up only 14.4 percent of the population. It is also possible that those teachers who reported spending over 30 percent of their time in lab are already committed to significant instructional time in the lab and therefore the UPDATE program has limited influence in advancing their time spent in lab instruction.

A third statistical test was performed to determine the overall mean scores which occurred in the clusters of questions. The mean scores are those of the entire population of respondents (n = 90). The possible range of the scores are 1 to 5. A score of 1 indicates the poorest response, while a score of 5 indicated the highest response. A score of 3 is essentially neutral or average. Therefore, a score greater than three would indicate that the UPDATE program had a positive effect in that cluster.

The first cluster represents Products. These are examples of student generated work which are UPDATE related. The overall mean response score for the program was 3.90, suggesting the physics students in participant's high school classes are generating UPDATE related work and to a good degree.

In the second cluster representing Physical Resources, the overall mean response score is 3.0. This result suggests that UPDATE material or equipment are being used physics classes but not to a very great extent. However, this may not accurately express the extent to which UPDATE material or equipment is actually used in the participants physics classes. Upon examining the questionnaire items selected to represent Physical Resources, one of the items asks about use of the UPDATE Resource Center. At the time when the questionnaire was administered, more than one of the campuses had not yet completed their Resource Center. In fact, at least one campus did not yet have a room available for their Resource Center. Therefore, it is quite possible that the participants were using UPDATE equipment to a great extent, but not the Resource Center, resulting in a relatively low mean for that cluster.

The third cluster represented the use of UPDATE related Ideas/Concepts in the physics classroom. The overall mean response for this cluster is 3.92. This strongly suggests that the participants were using UPDATE related ideas/concepts to a great extent.

The fourth cluster represented Skills gained at UPDATE. The overall mean response for this cluster is 4.13. This is the highest mean among the five groups. It is strong evidence that participants gained Skills in the UPDATE program and that the newly gained skills are having a very positive effect on participants' physics instruction.

The fifth and last cluster represents Attitude. This is general category which includes such aspects as enthusiasm, confidence, and curricular changes. The overall mean response is 3.97. Again, this is a very positive score and it reflects a general affective change due to the UPDATE program.

Aspects of the UPDATE Program

The relatively high mean scores in each of the five clusters suggest that the UPDATE program has had a positive influence on participants' instruction. As interview data also suggest, there are aspects of the program which may have significantly contributed to the positive change in instruction. Questionnaire items 22 through 31 were specifically constructed to identify those aspects of the program which the participants felt contributed to the improvement of their physics instruction. The ten items listed represent the major aspects of the UPDATE Program which were generated by previous questionnaire and interview data. Respondents were asked to indicate the extent to which each of the ten aspects of the UPDATE program has contributed to the improvement of their physics instruction. There are five possible responses ranging from one to five, with one being *Not at all*, and five being *To a very great extent.*

The overall mean scores are as follows:

22.	Summer Labs	Mean score 3.81 with a standard deviation of .787
23.	Summer Lectures	Mean score 3.59 with a standard deviation of .868
24.	UPDATE Resource Center	Mean score 1.97 with a standard deviation of .971
25.	Networking with Teachers	Mean score 3.69 with a standard deviation of .962
26.	Networking with UPDATE Staff	Mean score 3.36 with a standard deviation of 1.02
27.	Teacher Demonstrations	Mean score 3.80 with a standard deviation of .872
28.	Field Trips	Mean score 2.70 with a standard deviation of 1.15
29.	Distinguished Speakers	Mean score 3.50 with a standard deviation of .957

30.	Participant's Resource Kit	Mean score 4.02 with a standard deviation of .830
31.	Academic Year Meetings	Mean score 3.43 with a standard deviation of 1.04

These data suggest most of the aspects listed made contributions to the physics instruction of the UPDATE participants. Summer labs refer to those lab experiences which took place at the participant's home campus. An overall mean score of 3.81 out of five suggests a that the Summer Labs were very important to the enhancement of the participant's physics instruction. Similarly, the Summer Lectures with a mean response score of 3.59, were considered important, but less so than the Summer Labs. This finding is consistent with previous questionnaire and interview data which indicated that most participants held the lab, or hands-on, aspect of the program in high esteem. And, although participants evidently enjoyed the lectures, they considered the labs a more useful component in terms of influencing their practice of teaching physics.

The UPDATE Resource Center received the lowest score of all the aspects listed on the questionnaire. With an overall response score of 1.97 and a range from 1.00 to 4.00, it is clear that The UPDATE Resource Center was not viewed as having an influence on participants' physics instruction. However, this does not indicate that participants felt that the concept of borrowing equipment or using UPDATE related equipment was a poor idea. As stated earlier, at the time of the administration of the questionnaire, the UPDATE Resource centers were largely not yet available at most of the UPDATE campuses. It therefore makes sense that the UPDATE Resource centers would have little or no influence on the physics instruction of the participants.

Networking with other physics teachers was also considered an important aspect of the program which influenced instruction. The mean response score of 3.69 suggests this aspect had considerable bearing on instruction. However, networking with UPDATE Staff was not considered as important as was networking with other physics teachers. The overall response score of 3.36 suggests it had a positive influence on instruction but clearly not as much as networking with other teachers.

The importance of teacher demonstrations was advanced by participants in previous questionnaires and interviews, and, as an overall response score of 3.80 suggests, it is also important to the overall UPDATE group in terms of instructional change.

Although several participants discussed field trips as an enjoyable aspect of the program in earlier interviews, the overall group clearly did not considered very important to physics instruction. With a score of 2.70, Field Trips were not considered as influential to physics instruction as other aspects of the program, with the exception of the UPDATE Resource Centers, which received the poorest scores.

One of the major distinctions between the first two weeks and the third week of the program was the Distinguished Speakers aspect of the program. In fact, the Distinguished Speakers could be considered the major difference between the "home" campus experience and the third week experiences. Therefore, the overall mean score of 3.50 not only suggests that the speakers had a significant effect on the physics instruction of the participants, but it also reflects the participants' positive view of the third week of the program in residence at the Amherst campus.

The highest score received by any aspect of the program was the Participant's Resource Kit. These are Kits given out each year to participants during the program. The contents of the Kits vary from year to year depending upon the major topics of the program for that year. The Kits, over the three years, have included such items as multimeters, lasers, and other electrical equipment useful in the physics laboratory. The Participant's Resource Kit received an overall mean response score of 4.02, clearly suggesting this aspect of the program had a strong influence on the participants' instruction.

The final aspect of the program listed on the questionnaire was the Academic Year Meetings. Although it received a mean response score of 3.43, which indicates it had a positive influence on physics instruction, it was also ranked the third lowest among all other aspects of the program listed.

CHAPTER 9

SUMMARIES & CONCLUSIONS

Focus Group Interviews

The four Focus Groups raised several interesting and important ideas. To begin with, all members of the Focus Groups stated that the UPDATE Program had influenced their own practice of teaching high school physics. Participants were eager to talk about the UPDATE program as well as what they had changed in their high school physics classes. The Dartmouth Focus Group was typical in the sort of responses they provided to the question of how their instruction might have changed. Don said, "Maybe more sophisticated, I think you just have more knowledge."

Carla said,

> It reinforced my belief that hands on is extremely important because there's a lot of pressure to do the traditional you know equations and do calculations and that's it. And time in schools and budgets now keep putting pressure on doing less experimentally and it made me personally stronger to say no, we have to have the money or I have to go through the struggle to have the kids do more hands on.

And Amos said,

> To some degree I find it re-energizing. I certainly wouldn't come back here the second time if it was a continuation of what I had done all year long with my kids in school, uh, it's completely different.

The other three Focus Groups gave remarkably similar responses. For the purposes of this study, the Focus Group's responses can be classified into two major categories. The first is what they found valuable about the program, and the second is how the UPDATE program had influenced their physics instruction. A synthesis of Focus Group responses clearly demonstrates that the UPDATE program offered a great deal to participants in both categories.

The following is a list of what participants found most valuable about the UPDATE program. The list is in order of frequency of response. The most frequently cited is appears as #1.

1. networking with other physics teachers
2. laboratory, or hands-on, activities
3. the Resource Kits
4. Teacher Demonstrations
5. the Distinguished Speakers during the third week in Amherst

The second category is the effect of the UPDATE Program on instruction. The following list is a synthesis of responses indicating what effects the UPDATE program had on the instruction of the members of the four focus groups. The list is in order of frequency, with #1 being the most frequently cited.

1. enhanced confidence & enthusiasm
2. enhanced physics knowledge (breadth of knowledge increased)
3. validation of teaching practices
4. enhanced laboratory skills

5. changed curriculum

6. new ideas for teaching physics

Individual Interviews

The Focus Groups were extremely valuable in raising general issues and identifying in a general way the valuable aspects of the program and the effect of UPDATE on participants' instruction. The Individual interviews allowed a more in-depth look at these same issues. Questions constructed for the individual interview were generated based on the responses of the Focus Groups. A set of questions was constructed for use in all the individual interviews, although the format was semi-structured, which allowed the participant and interviewer the freedom to explore issues (see Appendix B for the individual interview questions).

Like the Focus Group's responses, the responses of the Individual Interview participants were remarkably similar. All four participants who were individually interviewed were asked about each of the aspects of the program the Focus Group had identified as being valuable as well as the effects of participation in the UPDATE program on instruction the Focus Groups had cited.

Overall, the individual interview data confirmed the Focus Group findings. Each participant who was individually interviewed identified essentially the same aspects of the UPDATE Program as being valuable to their physics instruction as did the Focus Groups. Discussions of those aspects the identified as valuable by participants in the individual interviews follow.

What was Valuable

Networking with Other Physics Teachers

This aspect of the program was cited very frequently in both Focus Group and individual interviews. Helen's opinion is fairly representative of others interviewed. She explained that she feels isolated and that there is no other physics teacher to help her when she needs help. Like most others in the program, she is not trained in physics. Therefore, she is uncertain about what to teach in physics and how to do it.

> Where I was, I was the only physics teacher. I had no one to say "*could you tell me how to use this table*?" And make the little ball fall off and you measure the acceleration, the circular acceleration, the circular velocity. I just couldn't do this. The circular velocity. The terms were very vague to me and I was always afraid that I would be using them improperly like I think I'm doing right now. I just was comfortable.

Other interviewees claimed that the isolation prevented an exchange of ideas, and UPDATE provide the opportunity to make connections for the exchange of ideas, as well as to develop camaraderie among peers.

> This is consistent with the development of an e-mail network, and an electronic community that wasn't in place when this program first went into operation. So uh, now I have some people who I've met personally and I'm maintaining an e-mail

> link with. So that helps to get ideas. It minimizes the isolation we all find in our classrooms.

Cheryl said that it provided the feeling of support.

> It's a good program. It's nice to be able to network with the people at U-Mass and the people in the area who are in the program. It's very supportive and I just got a lot of stuff out of it in a lot of different ways.

In summary, networking with other physics teachers provided the opportunity to meet and collaborate with peers as well as to exchange ideas for physics teaching including methodologies. It also was viewed as creating a support system which would reduce the isolation most physics teachers feel, since there is usually only one physics teacher in a given high school. Questionnaire data confirmed the perceived value of networking with other teachers. Item #25 asked specifically about the value of networking with other teachers in terms of enhancing instruction. The overall mean score of 3.69 out of a possible 5 indicates a fairly high agreement among the general population of UPDATE participants.

Participants considered networking one of the most important and useful aspects of the UPDATE program. Networking began during the first two weeks of the program where teachers met at their home campus. This turned out to be a considerable benefit as many teachers who worked in school systems geographically quite close to each other had not had the opportunity to meet, let alone work together. The UPDATE program acted as a common site for teachers in a given geographic area to meet. In some areas, such alliances already existed where teacher in a local area would meet and share ideas. In the Dartmouth area, several teachers indicated that an alliance had been started several years ago but it was very informal. The UPDATE program provided a structure for local alliances to form and take place. In addition, when the entire UPDATE population gathered in Amherst for the third week, teachers from all geographic regions in and around Massachusetts met. A suggestion made by several participants during the second year of the UPDATE program was for program directors to offer "mixers," where participants could meet informally and make connections. Due to that request, a barbecue was held for the third year participants during the third week of the program in Amherst, which was very successful.

The other reason why networking was considered an important part of the program was that program directors largely felt UPDATE should be for physics teacher enhancement, which meant that the topics were entirely physics. There was no educational aspect to the program during the three week summer institute. Therefore, teachers shared ideas for teaching during informal times of the program, such as lunch.

<u>Laboratory Activities</u>

The extensive laboratory activities were cited as very important and one of the reasons that kept participants coming back to the program for a second and third time. Interviewees found the lab activities valuable for a variety of reasons. Cheryl finds that the lab activities gave her more background and prepared her more for her own lab activities.

> They were helpful in giving me a stronger background and understanding. For instance, we did the Milliken oil drop thing this year, which I had never done before, but I always talk about it in both chemistry and physics. So I actually got to play around with that a little bit and it gave me some more experience. So it gave me a better background, but it didn't translate directly into my labs in that respect.

Fred agrees. He states that the lab activities helped his preparation but they were not directly applicable to his classes.

> Yes. That had an effect in certain respects. As I have said, many of the lab experiences weren't directly transferable to my teaching assignment. But at the same time. I think they prepared me to take on other teaching assignments.

Overall, the Lab Activities which took place during the first two weeks of the summer were found valuable because they provided the opportunity to learn new lab skills, and gave participants a familiarity with sophisticated lab equipment, which in turn enhanced their confidence. It also enhanced the participants' understanding of the concepts that were being explored in the lab, as well as providing new ideas for lab activities in their own high school physics classes.

Questionnaire data indicates that Lab Activities were very important to the enhancement of instruction. Item

#22, Summer Labs, received an overall mean response score of 3.81, which was the second highest among all program aspects listed on the questionnaire, confirming the importance of the Lab Activities.

Physics is traditionally presented as a laboratory science in high schools, where lab activities are an integral part of the curriculum. Therefore, teachers are very aware that they need to understand and present interesting and informative lab activities to their students. The lab activities offered at UPDATE gave teachers the opportunity to not only learn new lab procedures, but also to gather ideas for presenting high school labs. However, most participants interviewed stated that the UPDATE labs were not very transferable to their high school classes. They cited the use of sophisticated equipment and lab activities too challenging for high school students. Nevertheless, participants thought the labs were valuable for other reasons. The labs gave them practice and familiarity with lab equipment, which led to enhancement of confidence with the use of lab equipment and a deeper understanding of the concepts under consideration.

<u>The Resource Kits</u>

The Resource Kits were also cited by all interviewees as an important part of the program. Many stated that they would not have had such equipment in their classrooms if it had not been for UPDATE.

Helen uses material from her Kits in her classes frequently. She cites a specific example:

> Yes, all those magnets. We got the Kits that were really good. The superconductivity thing. Which, my first project was on buckyballs. I did an integrated project with the chemistry of buckyballs along with the superconductivity from the physics perspective. And the kids made the buckyballs, had to analyze the structure and had to come up with a use of it. So they first had to totally understand this, and then have the historical background. And they came up with encapsulating medicine in the buckyball and adjusting it and everything. But they loved the superconductivity part. That kit is very nice. I did a project at the Museum of Science last fall. Another teacher and I made a workshop for physical science teachers in the area which ran for a day. So we had to work with the scientist, the people who were in the museum. They have a very nice superconductivity demo that they do, which is no better than what we do. And yet they are the Museum of Science. So my students liked that a lot. So that's something that I would never have bought.

Fred claims the Kits were significant to him and that his student use materials from the Kits routinely.

> Well, one of the most significant is that all the materials that I have received as part of Kits during the three years have found their way into the students' hands. Everything from the multimeters to the various demonstration devices, where the students are using them.

The Resource Kits were viewed as very valuable by all interviewees. The Kits provided participants with equipment many would not have had otherwise. Questionnaire data indicates that the UPDATE population as a whole held the same view. Item #30, Participant's Resource Kit, received an overall mean score of 4.02 out a possible five. This was the highest score received by any aspect of the

Program, distinguishing the Resource Kits as the most valued aspect of the program among those listed.

Most high schools currently have very limited budgets and so physics programs have little opportunity to own or even hope for owning sophisticated lab equipment. Each year a kit of several items would be given out to participants for their use during the program and to take with them for use in their high school physics classes. Participants universally, appreciated the equipment provided to them by the UPDATE program. The Kits were important for several reasons. First, the equipment provided in the Kits were useful in many areas of physics, so teachers could use much of the equipment for a large part of the year. Secondly, several teachers claimed that they had no real experience with such lab equipment and came to understand why and how it was used. Thirdly, understanding how the equipment worked and was used helped participants to understand the concepts that were under consideration in the labs. Finally, they were able to take the equipment back to their classes and use them with a good understanding of their function and use.

Teacher Demonstrations

Time provided for teacher demonstrations was important to all teachers interviewed. Although time was provided for the demonstrations, they were almost entirely organized by participants. They felt it was very valuable resource for finding new ideas for use in their own physics classes. It also helped build camaraderie among physics teachers, and provided the opportunity to network with peers.

> Oh, Yeah. That was excellent. Uh, some people had such access to the technology department that they can make these things that are just phenomenal. And it was nice to see what they could make. You could go to lunch for days and pick their brains and find out how to do it.
>
> They were helpful. Uh, it was a matter of sharing. I was able to not only present some ideas that I had, but I was able to see some very fine ideas and presentations that probably enhanced my own technique. That probably was a major thing. I think that I put on some very nice presentations because of the wonderful people I have been able to copy.

Perhaps the part of UPDATE most cited as generating new ideas for teaching physics was the teacher demonstrations, which also provided the opportunity for teachers to network, and build personal relationships with peers. Questionnaire item #27, Teacher demonstrations, received an overall mean score of 3.80, which rankled third among all other Program aspects listed, confirming the relative importance interviewees placed on this aspect of the entire UPDATE population.

The popularity of this aspect of the UPDATE program is related to the importance of networking. Although the Teacher demonstrations were enlightening, they were also highly entertaining, adding a good deal of enjoyment to the UPDATE experience. In addition, they were frequently observed to be catalysts for teacher exchanges.

Distinguished Speakers

Considered by some to be synonymous with the Third Week activities, the Distinguished Speakers were very popular among participants. They universally generated enthusiasm, and inspiration. Interestingly, despite the fact that the Distinguished Speakers were outstanding experts in their field, interviewees did not cite gaining new insight into physics as what was most important about the Speakers. Instead they enjoyed the Speakers because they considered them to have "celebrity" status. Helen said, "The guest lecturers that we had at Amherst. It was very nice, that if something came up that I could mention the name and I could say that this is someone that I have met." Asked if she meant lecturers like Phil Morrison, Helen replied, "Yes. That I have shaken his hand. The astronauts. The kids are just hypnotized by saying you have spent a week with an astronaut."

Although interviewees were very enthusiastic about the Distinguished Speaker aspect of the program, the questionnaire data indicated the group as a whole felt somewhat less enchanted. The Distinguished Speaker aspect of the program received an overall mean score of 3.50, indicating the UPDATE population viewed it as valuable, but not to a great extent. However, the Focus Group interviews took place during the third year of the program which hosted astronauts as Distinguished Speakers. The astronauts were immensely popular and seemed to overshadow many of the Distinguished Speakers of previous years. The questionnaire was administered at the end of the program and participants may have been viewing the program more as a whole, that is over three years. This may account for the enthusiasm of the interviewees held for the Distinguished Speaker aspects and the relatively lower score from the questionnaire.

Other aspects of the program which were cited less frequently by interviewees were, Field Trips, and Networking with UPDATE Staff. Both received mixed reviews from interviewees, although both aspects were discussed in both Focus Group and Individual Interviews. The overall mean scores from the questionnaire showed Networking with Staff to be somewhat important with a score of 3.36. However, Field Trips had a mean score of 2.27, which falls well below the average 3.00 mark. Participants who felt the Field trips were important primarily cited gaining an appreciation for practical applications of physics. However, many others thought the field trips were trivial, took up too much time, or were not interesting or valuable in comparison to other events.

Those who thought Networking with UPDATE Staff was valuable cited similar reasons as networking with other teachers. That is, the formation of collaborations. However, many felt the primary value of Networking with UPDATE Staff was in forming a resource for information (such as answering questions) as well as for borrowing equipment.

Conspicuously absent from the list of Program aspects interviewees found valuable is the Academic Year Meetings. Many members of the Focus Groups felt the meetings were too difficult to attend because of time constraints during the academic year. Others felt the Meetings were not as productive as they might have been because of the reliance on group work, and some group members had inconsistent attendance. During the individual interviews, as well as the focus group interviews, teachers were given the opportunity discuss any aspect of the program they felt important or that had an effect on their instruction. The were not directly mentioned in any of the individual interviews and were not held in high esteem by the Focus Group members.

Questionnaire data does not really confirm this view. The Academic Year Meetings received an overall mean score of 3.43 indicating they were of value to the overall population of UPDATE participants.

The UPDATE Resource Centers also fared poorly in both the interviews and the questionnaire. The overall mean score for the UPDATE Resource Centers was 1.97, indicating that the Centers had not contributed to instruction to any significant extent. However as previously discussed, the Resource Centers were not fully, and in some cases not even partially, functioning at each campus at the time data was collected.

The Effect of the UPDATE Program on Instruction

In an effort to collect evidence of the influence of the UPDATE program on instruction, individual interview and questionnaire data were classified into one of five groups. As previously discussed, the groups were an attempt to find the extent to which the UPDATE program had affected the instruction of participants by looking at Products, Physical Resources, Ideas/Concepts, Skills, and Attitude. Examples in each of these areas were offered by the individuals interviewed and are summarized below.

Products

Most interviewees could not cite very specific examples of UPDATE related work that had been done by students, although all said that their students had participated in activities that came from the UPDATE Program. Some general examples of student work included a bottle rocket project and electronic projects using breadboards. Questionnaire data yielded a result of 3.87 out of a possible 5 for the Product group. This certainly strongly suggests that the students of the overall population of UPDATE participants were producing UPDATE related work in their high school physics classes.

There could be several reasons for the apparent discrepancy between the fact that interviewees could not cite specific examples of products, and the relatively high rating of the products items on the questionnaire. To begin with, the interviewees were not given the interview questions in advance, therefore they had to respond to the interviewer in a spontaneous fashion. The spontaneity required of the participants could have caused them to omit details because they did not have the time to prepare, or think deeply about their response. Another possibility is that the students of the interviewees were generating products, but during a time of the academic year quite removed from the time the interview took place. Therefore, the products would not be fresh in the minds of the interviewees and hence not mentioned. The other possibility is that the interviewees more accurately represented the actual state of product generation and the questionnaire data represented a false indication. This could have happened if the participants felt that their students should be generating UPDATE related work even though they had not yet done so. Perhaps teachers were planning to have their students generate work, or the questionnaire item actually triggered the idea that their students should be generating UPDATE related work.

Physical Resources

Interviewees cited the frequent use of their Resource Kits in their physics classes. Some of the most used materials were multimeters, magnets, lasers, and electronic components. Other Physical Resources included teaching units developed in the Academic Year Meetings. However, most interviewees stated that they were not using an entire teaching unit but bits and pieces which were often combined into their existing lab activities. Therefore, teachers were using the UPDATE teaching material to augment what they were already doing. The overall mean response score on the questionnaire was 2.99 for Physical Resources. However, the cluster of items which determined this score included one regarding the UPDATE Resource Center. If the Resource Center is not considered because of its unavailability to participants, then the mean score becomes 4.02. This score confirms the view of the interviewees, indicating the Physical Resources affected the instruction of the UPDATE population to a great extent.

Participants identified the Resource Kits as being of considerable value in the previous section. However, physical resources also include teaching units. Since the Academic Year Meetings are primarily used for the development of teaching units, it makes sense that teaching units would be available to teachers and that they would be applicable to the high school classroom. Most participants interviewed claimed to use the teaching units that they had developed during the Academic Year Meetings. However, few stated that they use the teaching unit as a whole unit, rather taking bits and pieces to use at different times throughout the academic year. Also, very few claimed to have used teaching units that were developed by other participants, although each campus made all teaching units developed at that site available to its participants. An effort was also being made to copy and distribute a collective set of teaching units from all the UPDATE sites, but at this writing it is not yet available to participants.

The lack of wholesale inclusion of participant developed teaching units in high school classrooms is not entirely surprising. The high school physics curriculum of the majority of participants interviewed was determined before the UPDATE program. Although the curriculum is almost always the choice of the teacher, most teachers have a notion of what should be included in a standard high school physics curriculum, and are reluctant to make substantial changes.

Ideas/Concepts

The indication that Physical Resources were used to a great extent in participants' physics classes, also speaks to the wide use of UPDATE related ideas/concepts in those classes. All participants interviewed claimed to use UPDATE ideas and concepts frequently on their physics classes. Most interviewees stated that they were doing more with electronics in their physics classes, including building circuits with breadboards. Another example of ideas/concepts used by interviewees was the inclusion of thermodynamics in their curriculum. In both cases, these topics were not well represented in the interviewees' physics classes before they attended the UPDATE program, either because teachers felt that the topics were not important, or because the teacher did not have adequate knowledge and was therefore uncomfortable with the subject. The questionnaire mean response score for this cluster was 3.92 out of a possible 5, suggesting UPDATE related ideas/concepts were very influential in instruction and widely used in participants' physics classes.

One of the most common questions teachers asked of staff upon entering the UPDATE program was, what should a high school physics class include? Universally, teachers were concerned with what colleges and universities expect high school students to know as they enter post-secondary education. Discussion around this topic took place formally and informally throughout the three years UPDATE was in progress. Teachers by and large did not feel they had the freedom to include topics in their high school physics classes that are nontraditional. Therefore, topics such as communication physics or space physics created considerable debate among teachers. One of the most significant outcomes of the UPDATE program was that it gave permission to its participants to engage in topics that they ordinarily would not have considered in their high school classes. Yet, teachers were still reluctant to make major changes in their curricula. So, UPDATE ideas and concepts are evidently being used in participants' physics classes, but as augmentations to the curriculum that already exits, and not as entire units or sections.

<u>Skills</u>

One of the goals of the UPDATE program was to provide the opportunity for participants to enhance their laboratory skills. The interviews confirmed that the goal was being met to a high degree. Although veteran physics teachers claimed to have lab skills such a working with high tech equipment, breadboarding, and creating electrical circuits, they admit the UPDATE program has enhanced their skills. For others, the skills were gained for the first time. The questionnaire mean response score for this cluster was 4.133 which was the highest of all clusters. The overall population evidently considered this aspect of the program very valuable and influential on their physics instruction, although the interviewees were less positive.

The participants individually interviewed were all veteran UPDATE participants, that is they all had participated more than one year. It is likely that because of their experience, they had considerable skills before entering the UPDATE program or by the end of the program had developed their skills and therefore chose not to emphasize that aspect of the program in their interviews.

Moreover, participants rated other parts of the program which were related to skills quite highly. For example, the laboratory activities and the Kits were rated among the highest of all aspects of the program. When asked about these aspects, participants largely stated that they learned how to use the sophisticated lab equipment at UPDATE and also learned to use the equipment in their Kits for the first time or to a grater degree. The skills involved to use both UPDATE lab equipment and kit equipment were what UPDATE hoped to develop and drove the activities presented in the labs.

Attitude

Among the influences of the UPDATE Program on instruction first cited by interviewees was their enhanced confidence and renewed enthusiasm. Along with a more confident attitude there came the willingness to make curricular changes, such as adding units, labs, demonstrations, and generally placing more emphasis on UPDATE related topics. The most frequently cited curricular changes included adding or augmenting thermodynamics and electronics. A questionnaire mean response score of 3.97 confirms that UPDATE has affected the instruction of its participants to a great extent. This score was among the highest of all clusters.

Universally, participants claimed to have enhanced confidence due to the UPDATE program. The confidence came in the form of their ability to understand the challenging concepts offered in UPDATE, such as quantum physics and low temperature physics. However, teachers were most proud of the fact that they could now answer student questions with more knowledge, which would lead to more student enthusiasm.

Another important part of the attitude cluster is evidence for a change of attitude toward the practice of teaching physics. The majority of teachers have a predetermined physics curriculum and are very reluctant to alter any aspect of it. Although, overall, participants have not made wholesale changes, the willingness to make even minor changes or alter their curriculum or teaching methods, such as including more and different lab experiences for their students, is evidence for a major impact by the UPDATE program. The willingness and practice of changing teaching practices to include more UPDATE related topics and labs experiences demonstrates that the UPDATE program affected the physics instruction of its participants. Considering that the mean response score for this cluster was the highest among all other clusters, and that interview data supports this finding, one may conclude that the UPDATE program affected the physics instruction of its participants to a great extent.

Overall, participants viewed their experiences in the UPDATE program as very positive. Data from interviews as well as questionnaires seemed to indicate a good deal of participant satisfaction. There were also strong indications that UPDATE influenced the physics teaching of participants, suggesting the program was well run and met its goals as a teacher enhancement program. Although there is no significant data to suggest the high marks received by the program may have been influenced by other factors, there are some considerations which may be made. To begin with, there are few physics teacher enhancement programs available, and none similar to UPDATE in the New England region. Therefore, the UPDATE program may be unusually attractive to those physics teachers seeking professional enhancement.

In addition, there are few physics teachers compared to teachers of other subjects. Commonly, there is only one physics teacher in a particular high school. It is also prevalent that the lone physics teacher does not have a full teaching load of physics classes, but is required to teach other subjects such as chemistry or math. This creates a significant need for support through enhancement and networking. This may suggest that the need for such programs is significant and so teachers would tend to show their appreciation for an effort to provide needed services.

Finally, new initiatives in Massachusetts require all high school teachers to become re-certified to teach in their field of choice. UPDATE is an opportunity for physics teachers to take the necessary steps for re-certification, which is basically an accumulation of college credits in physics. It may be possible that the UPDATE program could have gained favorable ratings from those teachers who were very grateful for the opportunity to fulfill the requirements necessary to continue their careers.

CHAPTER 10

RECOMMENDATIONS

There are two significant outcomes of this study. First, it appears that the UPDATE Program had a considerable effect on the physics instruction of its participants. There was a very high degree of agreement between the Interview data from both Focus Groups and Individual Interviews and data from the questionnaire. Participants are more confident, enthusiastic, have more physics knowledge, and are changing their teaching practices to include more UPDATE related topics.

These are important changes which should be recognized by the science education community. Significant changes have taken place in participants' instruction creating more effective and competent physics teachers. However, these successes reach beyond individual classrooms. The UPDATE program allowed and encouraged the opportunity for teachers to create a support system that builds a physics education community which, for the most part, did not exist before. It also created an alliance between secondary schools and the University system which is essential for progress in physics education.

The second significant outcome of this study was the identification of those aspects of the UPDATE program that were highly successful in facilitating participants' change in instruction. At the same time, those aspects of the program that were less successful were also identified.

Identifying both successful and unsuccessful aspects is useful in recommending a structure for future teacher enhancement programs. These findings should be considered by those who propose future programs.

Recommendations for Future Programs

Interview and questionnaire data conducted for this study, as well as previous evaluative data, suggest that the program as a whole was well constructed and valuable in influencing participants' physics instruction. This collective data may also be useful for those who are in the process of constructing similar educational programs. The following aspects of the program have been identified as the most valuable and successful aspects of the overall program from the collective UPDATE evaluation data, and serve as recommendations to be considered for subsequent similar programs.

The program was applauded by participants for the academic rigor of its physics content. Participants seemed to want to learn physics, particularly physics that was contemporary and not well represented in the high school curriculum. Many teachers admitted that UPDATE topics were largely unfamiliar to them and that they were not including the topics in their physics teaching because they either were uncomfortable with their level of understanding of the topics or they considered them less important than other more traditional high school physics topics. Maintaining high academic standards and engaging in rigorous activities challenged teachers and gave them incentive to participate and the interest to bring what they had learned back to their high school classes.

In each of the three years, the UPDATE Summer Institute took place primarily during the early summer. The Summer Institute portion of the program was usually scheduled for the first three weeks in July. The timing of the program is important to teachers. Most school systems end their academic year near the end of June. At this point teachers are still focused on school related topics and issues. A short break before the summer program begins allows teachers to make the transition between teaching and attending lectures and labs. However, it is important that not too much time pass as momentum is lost and teachers lose enthusiasm for participation. The three week program is a substantial commitment for most teachers. Many teachers work at part time jobs during the summer and stand to lose summer income for attending a three week program. Others have child care issues and need assistance in attending a summer program. Therefore, the stipend has been cited as having significant value in allowing many teachers to attend a summer program of this length.

In addition the length of the program is important to consider. A three week commitment in the summer is a substantial time for a summer institute. Moreover, offering a third residential week is somewhat of a risk.

In the case of UPDATE, teachers were asked to leave home for a week to live in less than ideal conditions, usually dormitory rooms. This sort of situation can create obvious hardships for some participants. Therefore, this aspect of the program must be very attractive to outweigh the inconvenience of residency.

The mixture of lectures and laboratory activities was also cited as being important to teachers. Lectures helped them achieve a greater level of understanding of the topics, and the labs gave them practical hand-on experiences that not only provided enhancement of lab skills, but also provided ideas for classroom activities. Overall, the laboratory aspect of the program was highly rated by participants because it offered teachers what they needed and wanted, that is, more experience, a greater understanding of lab physics, and enhanced confidence. This aspect of the program was critical in influencing the participants' physics teaching.

The allocation of time for events occurring throughout the program was also considered important. One of the most improved aspects of the third year of the program from the participants' point of view was the schedule. What was different from previous years was simply more time built into the day for teachers to reflect, relax, and communicate with other teachers. The schedule for the first year was fairly ambitious. The second year was similar but strides were made by program directors to provide participants with more time between lectures and labs, and more free time in general. These changes largely took place because of the feedback program directors were receiving from evaluators. The third year of the program was considered by participants to be better than the first two years in terms of scheduling. Although teachers appreciated the efforts of staff as well as the rigor of the lectures and labs, they universally felt the more flexible schedule in the third year was superior to earlier more ambitious schedules. One of the most common concerns regarding the ambitious schedule was not enough time between lectures and labs. Often, teachers would not complete a lab before having to leave to attend a lecture on time. Many would have to go back to the lab at the end of the day to complete the lab they began earlier in the day. Also, teachers needed time to reflect and to discuss ideas and concepts which were presented in lecture or lab. It was not unusual for several teachers to stay after a lecture or lab was over to ask questions or discuss points of clarification with the lecturer or lab instructor. A more flexible schedule allowed for this sort of dialog to exist. Finally, more unstructured time allowed participants to network with other physics teachers.

Networking was considered by participants to be one of the most important aspects of the program. Sharing ideas for teaching, building camaraderie, reducing the feeling of isolation as physics teachers, and building a support system, were all suggested by participants as important components of networking. Moreover, networking was not only successful among teachers, but was an important step in building bridges between high school teachers and University staff. Such alliances are very important to the advancement of physics education on both high school and college levels.

The kits of lab equipment were very important to participants. Commonly, high schools have limited budgets and physics teachers rarely have the opportunity to work with modern high tech lab equipment. The ability for teachers to use lab equipment otherwise unavailable to them was considered one of the most important benefits of the program. Therefore, any lab equipment that could be made available to participants would be of obvious benefit and would likely be used in the their high school physics classes. Such was the case with the Participants' Resource Kits. Cited in nearly all interviews and rated highly on the questionnaire, the material in the Resource Kits were clearly popular with participants. The Resource Kits not only contained useful items, such as multimeters, but actually bridged the gap between the UPDATE program and the participants' physics classrooms. Many of the participants interviewed discussed how items from the Kits were being used in their high school physics classes and claimed they would not have such equipment if it had not been provided by the UPDATE program.

The Distinguished Speakers were very important to participants. High school teachers are in the position of influencing young people. It was important to participants to be able to inspire and develop student interest in physics. Many teachers indicated in interviews that they could talk about and inspire their students by telling them of their experiences with distinguished speakers such as M.I.T. scientist Philip Morrison and NASA astronauts. However, beyond the ability to impress students, the distinguished speakers provided a meaningful experience to the participants themselves. Many participants stated that they were thrilled to meet some of the distinguished speakers and were personally inspired by the experiences.

Perhaps the most important aspect of this program was that high school teachers felt that they were treated as peers by University staff. Participants indicated in interviews that the program promoted a sense of community between the University level and the high school level. Few groups appreciate the value of education as much as high school teachers. It is an essential part of their mission as high school teachers to advocate for education and try to instill a sense of appreciation of learning in their students. Therefore, any attempt by the University system to embrace high school teachers as colleagues with a common purpose, is a formula for success.

The academic years meetings were not universally viewed as valuable by the participants. As the focus group and individual interviews indicated, there were mixed feelings about the usefulness and practicality of this aspect of the program. In fact, participant attendance varied widely from campus to campus suggesting teachers were not finding them as valuable as the summer institute. Teachers' busy work schedules, family and other personal obligations as well as the inconvenience of commuting to and from the UPDATE sites are factors which need to be considered when offering follow-up meetings of this nature. Therefore, the activities and content of such meetings must be viewed as important and of high quality for participants to make the effort needed for regular attendance.

Recommendations for Future Evaluation of the UPDATE Program

The UPDATE program was atypical of many teacher enhancement programs in that it took place over three years and at four independent campuses, each with its own facilities and staff. It also had the unique features of a week of residency in Amherst, as well as follow-up meetings which took place during the academic year. Evaluation of the UPDATE Program took place primarily by questionnaires administered at the beginning and end of the program, as well as by individual interviews during the three week summer institute. The fundamental purpose of the evaluation was to provide stakeholders with the information necessary to make decisions regarding issues of funding. Yearly reports were constructed using data largely from questionnaires along with some data from interviews. In addition, such information also served to provide information to program directors that helped them make needed program modifications. However, because of the unique nature of the UPDATE program there were other possible modes of evaluation that could have taken place, and would be recommended for similar subsequent programs.

The Focus Groups that were formed as part of this study were found to be invaluable in identifying participant concerns and issues. They also provided the interviewer with the ability to inquire about all aspects of the participants' experience in the program. The information from such focus group interviews would be invaluable to program directors, keeping them informed and aware of participant concerns and providing feedback on all aspects of the program. Therefore, it would have been valuable to design and conduct focus group interviews throughout the program. Participants from each campus could be solicited to be part of an on-going focus group representing their campus which would meet throughout the program for that year. This would include the two weeks at the "home" campus, the week of residency at Amherst, and the Academic Year Meetings at their campus. Important data could then be gathered regarding each of these major aspects of the program.

The individual interviews were also very valuable in probing the important issues and concerns as well as the effect of the Program on instruction. There were four individual interviews conducted for this study which yielded revealing information, suggesting that more individual interviews would not only yield more valuable information, but help to substantiate previous findings. It is suggested that a greater cross-section of participants be interviewed from each campus. Since it was determined that years of UPDATE participation was a significant factor in this study, interviews might be arranged with participants with varied UPDATE experience.

The questionnaires administered throughout the UPDATE program were essentially designed to gather information to investigate the merit or worth of the program by looking at the extent to which participants felt the program met its stated goals. The questionnaire used in this study was no exception, as only part of its purpose was to determine the extent to which the UPDATE program had affected the physics instruction of its participants. Subsequent questionnaires might be administered more frequently and be more specifically designed for particular purposes. For example, it would have been useful to administer a questionnaire which was specifically designed to address issues of instruction and the effect of participation on instruction. Other questionnaires could be constructed using interview data and previous questionnaire data to investigate particular aspects of the program.

Classroom visits may also be useful to collect data regarding the use of UPDATE related material or ideas. However, this method is very time consuming and the researcher should weigh the time spent traveling to various schools against the possible gains of data collection by direct observation.

The interplay of all modes of evaluation data is important and recommended for construction of evaluation tools. For example, questionnaire data can be used to construct interview questions, and the subsequent responses can be used to construct items on ensuing questionnaires. As evaluation tools are needed they should be constructed using findings from all forms of previous available data.

Since the UPDATE program took place over three years, it would have been possible to initially identify those teachers who planned on participating for the entire three year period. Collecting data from that select group frequently over the three year period would allow evaluators to "track" participants and possibly obtain a more evolutionary view of the program. Information regarding changes in the program over time as well as the perceived needs for change by this group would be particularly valuable for program directors in their efforts to maximize the experiences of the participants and improve the program from year to year.

Finally, questionnaire data could be used to identify more correlations between items. The questionnaire data collected in this study was primarily used for confirming interview findings and identifying aspects of the program participants found influential to their physics instruction. However, the identification of significant correlations among questionnaire items could suggest important relationships which should be subsequently explored through further evaluation techniques.

APPENDIX A

UPDATE QUESTIONNAIRE

UPDATE QUESTIONNAIRE
Spring 1996

Please complete the following questionnaire. Your input is very important and will be valuable in assessing the UPDATE program.

Please circle the letter of the response which applies to you.

1. The campus with which I am associated is:

   a. Amherst
   b. Boston
   c. Dartmouth
   d. Lowell

2. The number of years I have taught physics is:

   a. 0-2
   b. 3-5
   c. 6-8
   d. 9 +

3. The number of years I have participated in the UPDATE program is:

   a. 1
   b. 2
   c. 3

4. My gender is:

   a. female
   b. male

5. The percent of time I spend doing laboratory activities in my physics classes each week is approximately:

   a. 0-10 %
   b. 10-20 %
   c. 20-30 %
   d. 30-40 %
   e. 50 % +

How well-prepared do you feel in each of the following aspects of physics teaching ?

There are 5 possible responses to each aspect of physics teaching listed.

1-Totally Unprepared 2- Poorly Prepared 3- Adequately Prepared 4- Well Prepared 5- Very Well Prepared

Show your opinion by circling the number (1-5) corresponding to your response.

6. Basic physics knowledge	1	2	3	4	5
7. Recent developments in physics	1	2	3	4	5
8. Other science knowledge	1	2	3	4	5
9. Physics laboratory instruction	1	2	3	4	5
10. Applications of physics to everyday life	1	2	3	4	5
11. Overall preparedness for high school physics teaching	1	2	3	4	5

Please indicate the extent to which you agree or disagree with the ten statements below.

There are five possible responses to each statement.

SD-Strongly Disagree D-Disagree N-Neutral Undecided A-Agree SA-Strongly Agree

Show your opinion by circling the letter corresponding to your response.

12. I spend more time on lab activities in my physics classes since my participation in the UPDATE program.	SD	D	N	A	SA
13. I rarely use UPDATE related ideas in my physics classes.	SD	D	N	A	SA
14. My physics instruction has improved because I have learned new laboratory skills in the UPDATE Program.	SD	D	N	A	SA
15. The UPDATE program promoted a "hands on" approach towards teaching physics.	SD	D	N	A	SA
16. Participation in UPDATE has not changed my attitude towards teaching physics.	SD	D	N	A	SA
17. My students have generated work using UPDATE related ideas or concepts	SD	D	N	A	SA

18. I have not changed my physics curriculum to include more UPDATE related topics.	SD	D	N	A	SA
19. My physics instruction has improved because I have learned new physics in the UPDATE program.	SD	D	N	A	SA
20. I have become more enthusiastic about teaching physics since my participation in the UPDATE program.	SD	D	N	A	SA
21. Participation in the UPDATE program has not changed my overall physics instruction.	SD	D	N	A	SA

Listed below are ten aspects of the UPDATE program.

Please indicate the extent to which each of these ten aspects of the UPDATE program has contributed to the improvement of your physics instruction.

There are four possible responses to each statement.

1- Not at all
2- To a small extent
3- To a fair extent
4- To a great extent
5- To a very great extent

Show your opinion by circling the number (1-5) corresponding to your response.

22. Summer labs	1	2	3	4	5
23. Summer lectures	1	2	3	4	5
24. UPDATE Resource Center	1	2	3	4	5
25. Networking with other teachers	1	2	3	4	5
26. Networking with UPDATE staff	1	2	3	4	5
27. Teacher Demonstrations (During the Summer Institute)	1	2	3	4	5
28. Field Trips	1	2	3	4	5
29. Distinguished Speakers (During the Third Week of the Summer Institute)	1	2	3	4	5
30. Participants' Resource Kits	1	2	3	4	5
31. Academic Year Meetings	1	2	3	4	5

Thank you for taking time to complete this questionnaire.

APPENDIX B

QUESTIONS FOR INDIVIDUAL UPDATE INTERVIEWS

The following questions are designed to acquire information in 5 general areas. It is within these 5 areas that evidence will be sought to determine the extent to which the UPDATE program has affected the work of the individual being interviewed.

The five areas are:

1.	Products	Specific examples of student generated work which were UPDATE related.
2.	Physical Resources	The use of UPDATE resources in the classroom such as teaching units, equipment from Kits, and items from the Resource Center.
3.	Ideas/Concepts	Ideas or concepts used in the classroom which were either in part or altogether taken from UPDATE.
4.	Skills	Skills gained in UPDATE used in any activity in class or lab. Examples are breadboarding & use of lab equipment.
5.	Attitude	Teacher and or student attitude towards physics, physics teaching or specific units or activities that can be attributed to the teacher's participation in UPDATE.

Interview Questions for guided, semi-structured interview format. These questions are intended as areas of discussion and not necessarily asked in order, or answered as yes or no answers)

1. How many years have you participated in the UPDATE program?

2. Why did you decide to participate in the program?

3. Did you rethink the topics you cover (your physics curriculum) as a result of participation in UPDATE? Please give specific examples.

4. Have you changed the way you teach physics since UPDATE? For example, has the percent of time you spend in the lab changed?

5. Are there other changes in your physics teaching? Please give specific examples.
6. Do you think UPDATE promoted a particular teaching style? (Like a lab oriented, hands on approach?

7. In what ways do you think UPDATE promoted that style?

8. What effect do you think your participation in UPDATE has had on your students?

9. If I were to ask your students to show me work they have produced using UPDATE related ideas, concepts or materials, what would they show me?

10. What materials do you use in your physics classes that are from UPDATE? (for example a teaching unit or a multimeter) Would you have used these if you had not participated in UPDATE?

11. What teaching unit or units have you used from UPDATE? Have you used bits and pieces in other activities? If so how? (i.e.: are they single focused units or related activities?)

12. Where did the units come from that you use?

13. What skills have you used in your teaching that can be attributed to your participation in UPDATE? (example: breadboarding) How often, and in what activities?

14. Have there been any spin-offs (daughter products) from UPDATE? for example, have their been other activities or student products that have arisen from UPDATE activities or ideas?

15. How have you used UPDATE ideas or concepts in your physics teaching?

16. Can you cite specific examples?

17. Has your attitude changed in any way? Either towards teaching physics, physics or in any other way? Do you think your students' attitude has changed in any way?

18. Specifically, what aspects of the UPDATE program helped you to enhance your physics teaching or physics course?

19. I would like to list several aspects of the UPDATE program. Please tell me the extent to which each has had an impact on your physics instruction or course, and in what way.

List

a. Labs
b. Lectures
c. Resource Center
d. Networking with other physics teachers
e. Networking with UPDATE staff ?
f. Teacher Demonstrations
g. Field Trips
e. Other ?

APPENDIX C

UPDATE QUESTIONNAIRE DATA SPRING 1996

ITEMS #1-31
Respondent vs Item Number

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A1	1	4	2	2	4	5	4	4	5	5	5	4	1	4	5	5	4	1	4	3	2	5	4	1	2	2	4	3	3	4	2
A2	1	4	1	2	4	3	1	3	3	3	3	2	3	4	4	2	3	4	4	4	3	2	2	1	2	1	3	1	2	3	5
A3	1	4	1	2	4	5	2	3	4	3	4	3	4	3	4	4	2	4	3	3	4	4	4	1	4	1	3	1	4	4	4
A4	1	2	3	2	3	5	4	4	4	5	4	5	1	4	5	1	5	1	5	5	1	5	4	4	4	4	4	4	4	5	4
A5	1	4	2	1	2	4	3	5	4	4	4	2	2	4	4	2	3	2	4	4	2	3	3	2	5	4	5	3	5	5	4
A6	1	4	3	2	3	5	4	5	4	5	5	4	2	4	4	2	4	2	4	4	2	4	4	2	4	4	4	2	3	5	4
A7	1	4	1	2	3	4	3	4	3	4	4	3	2	4	4	2	4	2	5	4	2	2	2	2	3	3	3	2	2	4	3
A8	1	4	2	1	2	3	2	4	2	3	4	4	2	4	4	2	4	2	4	4	2	4	5	2	4	4	4	2	3	5	2
A9	1	1	1	2	2	4	2	3	3	4	4	4	1	2	4	2	5	2	5	5	2	2	4	1	3	3	5	1	4	4	2
A10	1	2	1	2	4	4	2	4	4	4	4	4	2	4	4	2	4	2	4	4	2	4	3	2	3	2	4	1	4	4	4
A11	1	4	1	2	3	5	3	5	4	5	5	3	2	4	5	4	4	2	4	3	2	4	4	1	5	5	5	2	5	5	4
A12	1	4	1	2	3	5	4	4	4	4	4	5	2	4	4	2	4	2	4	4	2	3	4	3	4	4	4	2	4	3	3
A13	1	4	2	2	3	4	3	4	4	4	4	4	2	4	4	2	4	2	4	4	2	4	4	1	3	3	4	2	4	4	3
A14	1	2	2	2	2	4	3	3	3	4	4	4	2	4	5	1	4	1	5	5	1	3	4	1	3	2	4	1	3	2	2
A15	1	4	3	2	3	4	4	4	4	4	4	4	2	4	4	3	4	4	4	4	3	3	3	1	4	4	4	2	3	3	4
A16	1	2	3	2	3	4	4	3	5	4	4	5	3	4	4	2	4	2	4	4	2	3	3	1	3	3	4	2	4	4	3
A17	1	3	1	2	2	3	2	3	3	3	3	2	2	3	4	2	4	2	4	4	2	3	3	3	2	3	3	3	3	3	3
A18	1	1	1	2	2	3	2	4	3	4	3	4	2	4	4	2	3	2	5	5	2	4	3	2	4	3	5	3	4	4	3
A19	1	4	3	2	2	4	4	4	4	4	4	4	1	5	4	2	5	1	4	4	1	4	4	1	4	4	4	3	4	5	3
A20	1	2	3	2	3	3	4	5	3	4	3	4	1	4	4	1	4	2	5	5	1	4	5	1	3	2	4	3	5	3	4
A21	1	4	2	2	4	3	3	3	3	3	3	5	2	5	5	1	4	1	4	5	1	5	4	1	5	3	5	4	4	4	3
A22	1	2	3	2	3	4	3	4	4	4	4	4	2	5	5	2	4	2	5	5	2	4	4	3	5	5	4	3	4	5	5
A23	1	4	2	2	3	5	4	5	4	5	5	5	2	5	4	2	5	1	5	5	1	5	5	1	5	5	4	4	4	4	4
A24	1	1	2	2	4	5	4	3	3	4	5	2	3	3	4	5	4	2	4	3	2	2	3	3	2	3	2	1	3	3	2

24/24
A = Amherst

Respondent vs Item Number

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B1	2	2	2	2	3	3	3	4	2	3	3	4	4	4	4	4	2	4	4	5	3	3	3	1	3	1	2	1	4	4	1
B2	2	3	2	2	4	3	3	5	3	3	3	3	2	4	4	3	4	2	4	5	2	3	3	1	4	4	3	3	3	3	4
B3	2	2	1	2	4	4	2	3	3	3	3	3	1	4	3	3	4	2	4	3	1	3	2	1	3	3	1	1	2	2	3
B4	2	3	1	1	3	2	3	4	3	3	3	4	1	4	5	1	4	1	5	5	1	4	5	4	4	4	5	5	5	4	5
B5	2	2	2	2	3	3	3	3	3	3	3	4	2	4	4	2	5	2	5	5	1	4	4	2	4	4	4	3	4	4	4
B6	2	3	2	2	2	4	3	4	3	4	4	4	2	4	4	2	4	2	5	3	2	3	3	1	2	3	3	2	3	4	3
B7	2	4	1	2	3	4	3	4	3	3	4	2	2	3	4	3	3	3	4	4	3	3	3	3	4	3	4	3	2	4	4
B8	2	3	3	2	2	5	5	4	5	5	5	4	2	3	5	1	4	2	3	4	3	4	4	3	5	5	4	4	5	5	5
B9	2	4	1	2	3	4	3	4	4	4	4	3	2	4	4	2	4	2	4	4	2	4	3	1	4	3	3	3	3	3	3
B10	2	4	3	2	2	5	4	5	4	5	5	5	2	5	5	2	4	2	5	5	1	3	3	3	5	5	4	4	4	5	2
B11	2	2	2	2	2	3	3	3	3	4	3	3	3	4	4	2	4	2	4	4	2	3	3	1	5	3	3	3	2	4	2
B12	2	3	3	2	3	4	4	4	4	4	4	4	1	5	1	2	3	2	5	5	1	5	5	3	5	5	4	5	5	5	5
B13	2	1	1	2	3	4	3	3	3	3	3	3	2	4	3	2	3	2	4	5	1	3	4	1	2	2	4	4	3	4	3
B14	2	1	1	2	1	3	3	4	3	3	3	4	3	5	5	1	3	3	5	5	1	4	4	3	4	4	3	5	5	4	1
B15	2	4	2	2	4	4	5	5	5	5	4	4	3	4	4	2	3	4	4	4	2	3	4	2	3	3	3	4	5	3	4
B16	2	4	1	2	4	5	4	5	3	4	4	1	2	3	4	4	3	2	4	3	2	3	3	1	2	3	3	2	3	3	3
B17	2	3	1	1	3	4	4	4	4	4	4	3	2	4	4	2	4	2	4	4	2	3	3	1	4	4	4	3	3	4	3
B18	2	4	3	2	3	5	3	4	5	4	5	4	2	4	5	1	4	2	5	4	2	4	4	1	4	4	5	3	3	3	3
B19	2	2	2	1	3	3	3	3	3	3	3	4	1	5	3	1	4	1	5	5	1	5	4	2	4	3	4	2	4	4	3
B20	2	4	2	2	3	3	4	3	4	3	4	4	1	5	4	1	5	1	5	5	1	4	3	1	4	4	3	3	3	3	3
B21	2	2	2	2	3	3	3	4	2	3	3	5	2	5	3	1	4	2	5	5	2	3	2	1	3	2	3	1	4	4	4
B22	2	3	3	2	3	4	4	4	4	4	4	4	2	4	4	2	4	2	4	4	2	4	3	1	4	3	4	2	4	4	4

22/23
B = Boston

Respondent vs Item Number

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
D1	3	4	2	2	3	5	3	4	4	4	4	4	2	5	5	2	4	2	4	5	1	4	3	2	2	3	5	4	4	5	3
D2	3	4	1	2	1	4	4	4	3	5	4	3	2	4	5	1	4	2	5	5	4	3	5	1	1	3	4	1	5	3	1
D3	3	2	1	2	2	4	2	4	2	3	3	4	2	4	4	2	3	2	4	4	2	4	3	3	3	2	3	3	3	4	3
D4	3	4	2	1	2	4	2	3	4	4	4	4	1	5	5	1	5	1	5	5	1	5	5	3	4	4	5	5	4	5	4
D5	3	4	3	2	3	5	3	4	4	4	5	4	2	4	5	3	4	1	4	4	3	5	4	1	4	3	3	3	4	4	2
D6	3	4	3	2	3	4	3	5	4	3	4	4	1	4	4	1	4	2	4	4	1	4	4	2	3	3	3	2	2	3	2
D7	3	4	2	2	3	4	3	5	4	5	4	3	2	4	5	2	4	4	4	4	2	5	4	2	5	4	4	4	2	5	3
D8	3	4	2	2	3	4	3	4	4	4	4	4	2	4	5	1	4	2	4	4	2	4	3	4	3	4	4	3	3	4	4
D9	3	3	2	2	3	4	3	3	4	4	4	2	1	4	5	3	3	2	4	4	2	4	3	2	3	2	4	2	3	4	3
D10	3	3	3	2	2	3	3	4	3	4	4	5	2	5	5	2	4	2	5	4	1	4	4	2	4	3	5	4	4	3	4
D11	3	2	3	2	3	4	3	2	3	4	4	5	2	5	5	2	3	2	5	5	2	4	2	4	4	4	3	2	3	4	3
D12	3	4	2	2	3	5	3	4	5	5	5	5	1	5	5	1	4	1	5	5	1	4	4	3	3	3	3	1	2	5	3
D13	3	2	1	2	2	4	2	3	3	4	4	4	2	4	5	3	5	2	4	2	3	4	3	3	4	3	5	3	3	5	4
D14	3	1	2	1	2	4	2	5	3	3	3	5	1	5	5	1	3	1	5	5	1	5	5	3	3	3	3	2	4	5	5
D15	3	4	1	2	3	4	4	4	4	3	4	5	1	4	4	2	4	2	2	4	2	4	3	1	4	1	4	2	3	4	2
D16	3	4	1	2	3	5	4	4	4	4	4	5	2	4	4	2	4	2	4	4	2	3	4	3	4	4	4	2	4	3	3
D17	3	4	2	2	3	4	3	4	4	4	4	4	2	4	4	2	4	2	4	4	2	4	4	1	3	3	4	2	4	4	3
D18	3	2	2	2	2	4	3	3	3	4	4	4	2	4	5	1	4	1	5	5	1	3	4	1	3	2	4	1	3	2	2
D19	3	4	3	2	3	4	4	4	4	4	4	4	2	4	4	3	4	4	4	4	3	3	3	1	4	4	4	2	3	3	4
D20	3	3	3	1	2	5	5	4	5	5	5	4	2	3	5	1	4	2	3	4	3	4	4	3	5	5	4	4	5	5	5

20/22

D = Dartmouth

Respondent vs Item Number

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
L1	4	4	2	2	2	4	2	2	3	4	4	4	1	4	4	1	4	1	4	4	1	4	4	1	2	3	4	4	3	4	4
L2	4	4	2	2	2	5	4	3	4	3	5	4	1	5	4	3	4	2	5	4	1	4	4	4	5	5	5	5	4	5	4
L3	4	4	2	2	4	4	3	3	5	4	5	4	3	3	5	3	4	2	4	5	2	4	2	3	4	5	5	1	4	5	5
L4	4	4	2	2	3	4	3	3	4	4	4	3	2	4	4	2	3	2	4	4	2	5	4	4	5	5	5	4	4	5	4
L5	4	1	1	2	3	5	4	2	3	5	4	3	1	3	4	2	4	2	4	3	2	3	3	1	4	2	4	3	4	3	3
L6	4	4	2	2	1	3	5	3	3	4	3	5	2	4	4	2	4	1	4	4	2	4	3	1	3	2	2	2	3	4	4
L7	4	4	2	2	2	5	4	3	4	4	4	4	2	4	4	1	5	2	4	5	1	5	5	2	4	3	4	4	5	5	5
L8	4	4	1	2	4	5	4	4	4	3	5	1	2	4	5	5	5	2	4	4	2	3	2	1	2	2	3	1	2	4	4
L9	4	2	3	2	1	3	3	3	3	3	2	4	2	5	5	2	4	1	5	4	1	4	4	3	5	5	5	3	2	4	5
L10	4	1	1	1	1	4	3	4	3	4	4	3	2	4	4	1	4	3	4	5	2	4	4	3	5	4	4	3	2	5	4
L11	4	4	1	2	3	4	4	4	4	4	4	4	1	4	4	1	3	1	4	4	1	4	4	3	4	4	4	2	4	4	4
L12	4	1	3	2	2	3	4	4	4	3	3	4	1	4	4	1	3	2	4	4	2	4	5	2	5	5	3	4	4	5	3
L13	4	1	1	1	2	4	2	3	3	3	3	5	2	4	4	1	3	2	4	4	2	5	2	2	4	3	4	3	3	4	4
L14	4	4	3	2	5	5	4	4	5	5	5	5	1	5	5	1	5	1	5	5	1	4	4	2	4	3	4	4	5	5	5
L15	4	4	1	2	3	5	4	3	4	4	5	3	1	5	5	1	5	1	5	5	1	5	5	2	5	5	5	2	3	5	5
L16	4	1	1	2	2	4	3	3	3	3	4	3	2	4	4	2	2	3	3	4	2	4	4	3	3	3	3	3	4	3	4
L17	4	4	2	2	4	5	4	4	5	5	5	5	1	5	5	1	5	1	5	5	1	5	4	3	4	3	5	4	5	5	5
L18	4	4	1	2	2	5	3	4	4	4	4	3	2	4	3	2	3	4	4	3	2	3	3	1	2	2	1	1	1	3	1
L19	4	2	1	2	2	4	2	4	3	4	4	4	2	4	4	2	4	2	4	4	2	4	2	3	4	4	4	3	2	5	4
L20	4	4	3	2	3	4	3	4	4	4	4	4	2	4	4	2	4	2	4	4	2	3	3	2	4	4	3	1	2	4	3
L21	4	3	3	1	3	4	4	5	3	4	4	4	1	5	5	1	4	1	5	5	1	5	5	2	5	5	5	5	5	5	5
L22	4	1	1	1	2	4	2	3	3	3	3	5	2	4	4	1	3	2	4	4	2	5	2	2	4	3	4	3	3	4	4
L23	3	4	1	1	3	4	3	4	4	4	4	3	2	4	4	2	4	2	4	4	2	4	3	1	4	3	3	3	3	3	3
L24	1	4	2	1	2	3	2	4	2	3	4	4	2	4	4	2	4	2	4	4	2	4	5	2	4	4	4	2	3	5	2

24/24
L = Lowell

APPENDIX D

FOCUS GROUP INTERVIEW QUESTIONS

1. What are your feelings about this years program at your home campus in terms of level of difficulty, pace, and appropriateness of topics ?

2. What are your feelings about the 3rd week at Amherst so far?

3. Has the program changed since you first participated? In what ways?

4. All of you have participated in UPDATE for more than a year. Can you discuss why you chose to participate again?

5. Has the program affected your teaching? If so, in what ways?

6. Has the program affected or influenced your physics curriculum? In what ways?

7. What do you think were the most important things you gained from the program?

8. I would like to read you the goals of the program. Please comment on whether you think they are appropriate, and the extent to which you think the program succeeded in meeting its goals.

   a. Provide participants contact with professional physicists & astronomers.

   b. Promote networking (reduce isolation) among physics teachers.

   c. Provide opportunity for participants to learn new physics.

   d. Provide opportunity for participants to enhance lab skills.

   e. Provide new ideas for teaching physics.

9. Do you think your participation in UPDATE had an effect on your physics students? If so, in what ways?

10. What would you like to have received from the program that you did not receive? or did the program disappoint you in any way? If so, how?

11. Were there any unexpected outcomes or effects (surprises) you experienced as a result of the UPDATE program? If so, what were they?

12. What are the characteristics of this program which should be characteristics of future or subsequent programs?

13. Are there any other issues or concerns you would like to discuss?

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